

EVALUATION OF GROUNDWATER EXTRACTION REMEDIATION ALTERNATIVE AT THE HELENA LANDFILL



Prepared for:

Mr. Jeff Towery
Acting Director
of
Public Works
**CITY OF
HELENA**



Hydrometrics, Inc.[®]

consulting scientists, engineers and contractors

AUGUST 1999

**EVALUATION OF GROUNDWATER EXTRACTION REMEDIATION
ALTERNATIVE AT THE HELENA LANDFILL**

HELENA, MONTANA

Prepared for:

Mr. Jeff Towery
Acting Director of Public Works
City of Helena
Helena, MT 59601

Prepared by:

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MONTANA
DEPT. OF ENVIRONMENTAL QUALITY
COMMUNITY SERVICES BUREAU

August 1999



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August 3, 1999

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Department of Environmental
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WMD/SWP
P.O. Box 200901
Helena, MT 59620

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MT-DEPT. OF ENV. QUALITY
PERMITTING & COMPLIANCE DIV.

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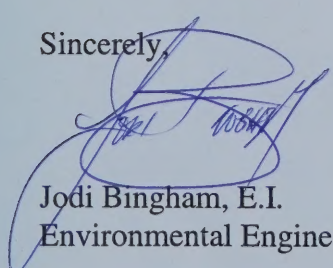
MONTANA
DEPT. OF ENVIRONMENTAL QUALITY
COMMUNITY SERVICES BUREAU

Dear Pat:

On behalf of the City of Helena, Hydrometrics completed a technical evaluation of groundwater remediation alternatives for the City's municipal landfill. I am enclosing a copy of the report "Evaluation of Groundwater Extraction Remediation Alternative at the Helena Landfill" for your review. This report includes technical information on the groundwater model and pilot test performed to evaluate the groundwater extraction remediation alternative. I am also enclosing a copy of the report "Second Addendum to Corrective Measures Assessment for the Helena Landfill" for your review and approval. This report includes an evaluation of two groundwater remediation alternatives and changes the City's preferred corrective action to groundwater extraction. A public meeting to discuss the new corrective measures is scheduled for August 12, 1999 and we would like to incorporate your comments into this meeting.

If you have any questions concerning these reports, please don't hesitate to call.

Sincerely,


Jodi Bingham, E.I.
Environmental Engineer/Chemist

Enclosures

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EVALUATION OF GROUNDWATER EXTRACTION REMEDIATION ALTERNATIVE AT THE HELENA LANDFILL HELENA, MONTANA

1.0 INTRODUCTION

This report presents the results of Hydrometrics' investigation of the groundwater extraction remedial alternative for the Helena landfill. This investigation was performed at the request of the City of Helena in conjunction with the Montana Department of Environmental Quality (MDEQ). The field work for this investigation was completed in June and July of 1999 and was performed in accordance with discussions between a technical group consisting of representatives from Hydrometrics, the City of Helena Public Works Department, and the MDEQ.

Groundwater flow paths leaving the landfill were predicted using a particle tracking model which traces the flow path of water particles through the groundwater system. A particle was placed at each cell of the model along the northern edge of the landfill and Times 1 and 2 and these particles were tracked over a period of 100 years. Figure 2-1 shows the landfill area and the path each water particle travels. A groundwater mound resulting from a septic tank located just east of the landfill on the north side of the landfill area produces a hydraulic cone of which causes a large percentage (25%) of the groundwater flowing beneath the landfill to flow west and north along the western edge of the landfill (see Figure 2-1). The remaining groundwater (75%) flows east and then generally north along National Avenue.

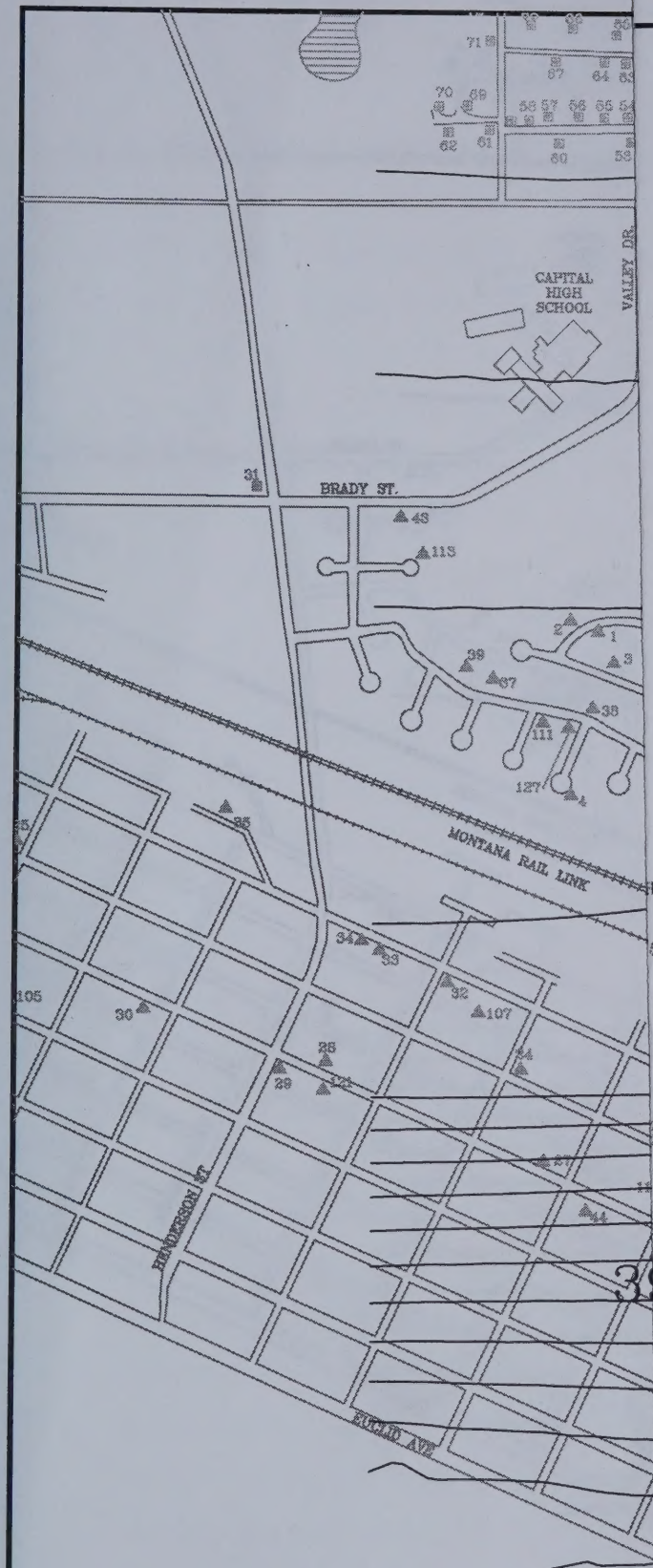
Four pumping wells were added to the model to simulate the effects of groundwater extraction. The existing groundwater extraction wells were also included. Water particles leaving the landfill were tracked again with four of the landfill monitoring wells located on Figure 2-1 shows the results of the particle tracking with all water particles leaving the landfill being captured by the four monitoring wells. The pumping rates required for complete capture were 20-25 gallons per minute (gpm) for the four western wells and 1 gpm for the eastern well for a total of 26-26 gpm. The City has proposed that the extracted

2.0 PRELIMINARY COMPUTER MODELING OF GROUNDWATER SYSTEM

To evaluate the potential effectiveness of a groundwater extraction system, a hydrologic modeling analysis was performed using MODFLOW. Selected model output and several sources of model input are included in Appendix A. Input files for the model will be provided in electronic form to the MDEQ; a hard copy is not included in this report due to the sheer quantity of data. To model the groundwater system in the area of the Helena Landfill, a grid was assigned to the area of interest including the landfill site and the surrounding areas. Next, model parameters such as hydraulic conductivity, transmissivity, and the depth to bedrock were assigned to each block of the grid using available well logs and pump test data (see Appendix A). The model was then "calibrated" by varying these input parameters and the recharge values associated with the golf course, soccer fields and stormwater outfall within acceptable ranges to reproduce the existing water table.

The groundwater flow paths leaving the landfill were predicted using a particle tracking model which traces the flow path of water particles through the groundwater system. A particle was placed in each cell of the model along the northern edges of the Phase I and Phase II landfills and then these particles were tracked over a period of 100 years. Figure 2-1 shows the landfilled area and the path each water particle traveled. A groundwater mound resulting from a stormwater outfall that discharges on the north side of the landfilled area produces a hydrologic divide which causes a large percentage (>95%) of the groundwater flowing beneath the landfill to flow west and north along the western edge of Bill Roberts Golf Course. The remaining groundwater (<5%) flows east and then generally north along National Avenue.

Next, pumping wells were added to the model to simulate the effects of groundwater extraction. The existing golf course irrigation wells were also included. Water particles leaving the landfill were modeled again with four of the landfill pumping wells turned on. Figure 2-2 shows the steady state capture scenario with all water particles leaving the landfill being captured by the four extraction wells. The pumping rates required for complete capture were 20-25 gallons per minute (gpm) for the three western wells and 5 gpm for the eastern well for a total of only 65-70 gpm. The City has proposed that the extracted



SCALE
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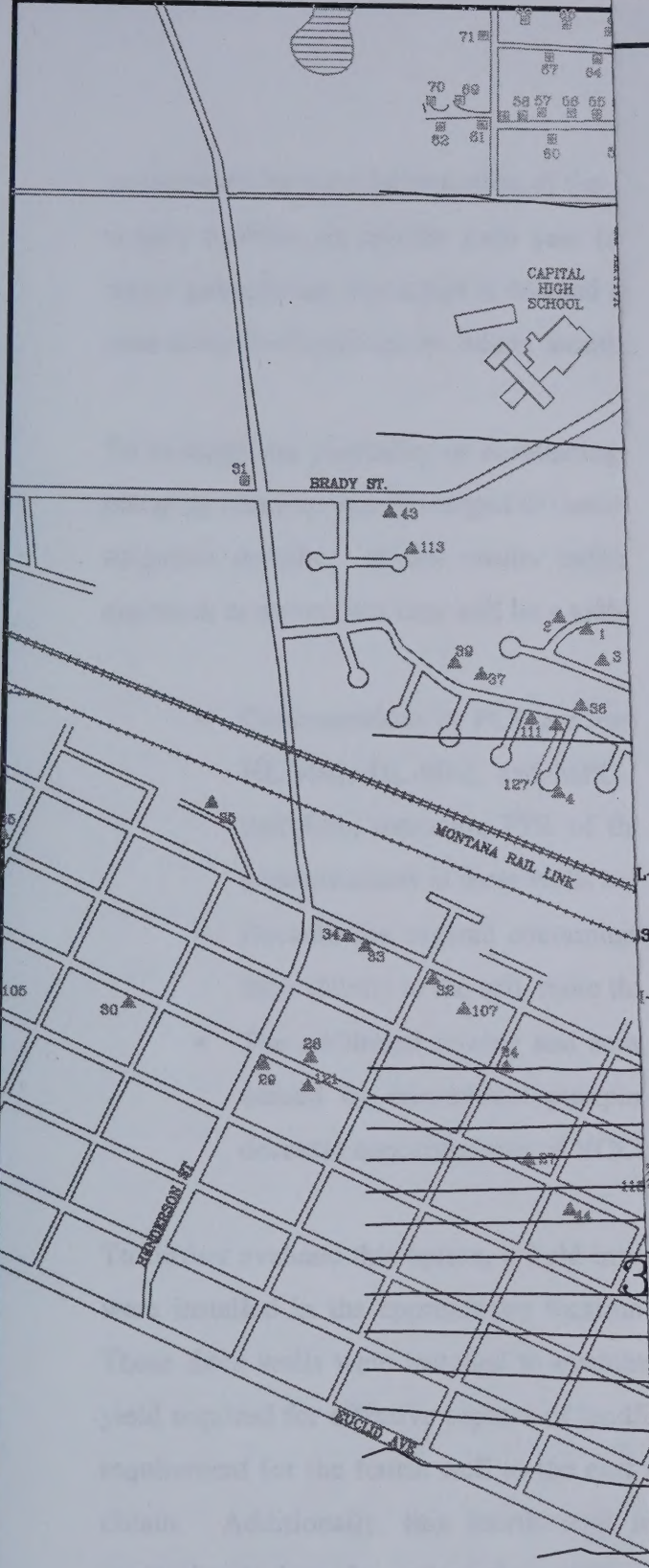
LEGEND

- L-1 ■ PIEZOMETER
- 33-6 ● MONITORING WELL
- ▲ 1-6 ▲ IRRIGATION WELL
- 80 □ DOMESTIC WELL
- ▨ INFILTRATION GALLERY (GROUNDWATER COLLECTION SYSTEM)
- GROUNDWATER POTENTIOMETRIC CONTOUR PREDICTED BY MODEL
- GROUNDWATER FLOW PATH PREDICTED BY MODEL
- ↘ STORM WATER OUTFALL FOR LAST CHANCE GULCH

GROUNDWATER FLOW PATHS
PREDICTED BY MODEL

FIGURE

2-1



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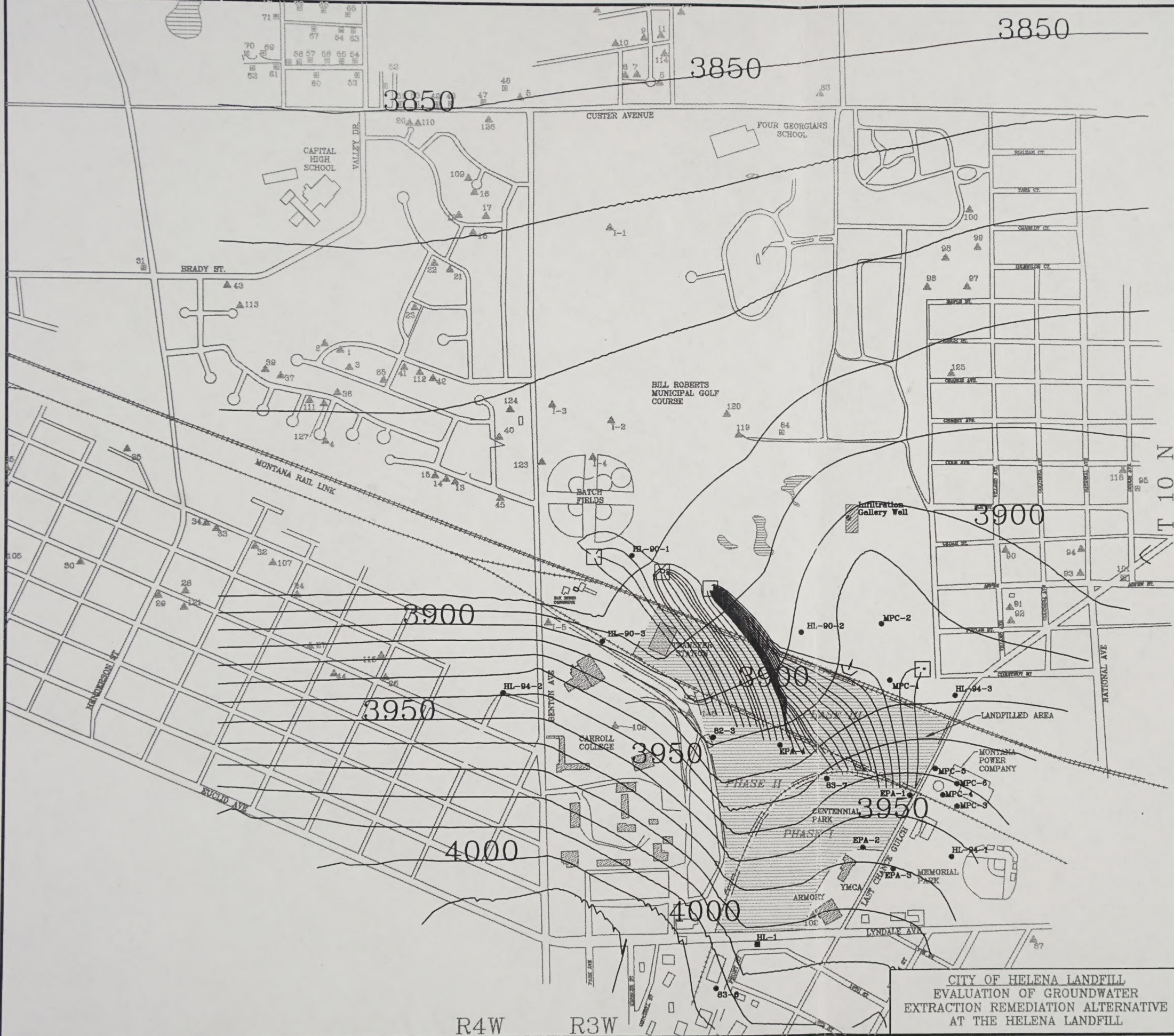
LEGEND

- L-1 ■ PIEZOMETER
- 3-6 ● MONITORING WELL
- 1-6 ▲ IRRIGATION WELL
- 80 □ DOMESTIC WELL
- PROPOSED EXTRACTION WELL
- ▨ INFILTRATION GALLERY (GROUNDWATER COLLECTION SYSTEM)
- GROUNDWATER POTENTIOMETRIC CONTOUR PREDICTED BY MODEL
- GROUNDWATER FLOW PATH PREDICTED BY MODEL
- STORM WATER OUTFALL FOR LAST CHANCE GULCH

STEADY-STATE
CAPTURE SCENARIO

FIGURE

2-2



SCALE
(In Feet) 800

LEGEND

- HL-1 ■ PIEZOMETER
- 68-6 ● MONITORING WELL
- I-6 ▲ IRRIGATION WELL
- 80 □ DOMESTIC WELL
- PROPOSED EXTRACTION WELL
- ▨ INFILTRATION GALLERY (GROUNDWATER COLLECTION SYSTEM)
- GROUNDWATER POTENTIOMETRIC CONTOUR PREDICTED BY MODEL
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CITY OF HELENA LANDFILL
EVALUATION OF GROUNDWATER
EXTRACTION REMEDIATION ALTERNATIVE
AT THE HELENA LANDFILL

STEADY-STATE
CAPTURE SCENARIO

FIGURE
2-2

groundwater be used for irrigation of the golf course or Centennial Park. However, irrigation is only feasible six months each year (approximately April through September). If year-round groundwater extraction is deemed necessary, an alternate use or disposal option would need to be developed for the winter months.

To evaluate the possibility of eliminating the need for a winter treatment option, a 180-day pumping scenario was developed to determine the effects of only extracting water during the irrigation months. Model results indicated that only 75% of the water particles were captured; however, this may still be a viable option for the following reasons:

- Concentrations of PCE are less than 0.020 mg/L in the compliance wells (wells HL-90-1, HL-90-2, and MPC-1, located along the northern landfill boundary); therefore, removing 75% of the contaminated water may be sufficient to bring concentrations in these wells below the MCL of 0.005 mg/L.
- Because the organic contaminants move slower than the water particles due to their affinity to the soil, more than 75% of these particles may be captured.
- The additional mixing and aeration of the groundwater within the capture zone caused by intermittent pumping of the extraction wells will help to further decrease concentrations of VOCs in the groundwater.

To further evaluate this option, a field investigation was conducted. Three extraction wells were installed in the approximate location of the three western wells used by the model. These three wells were installed to evaluate the ability of the aquifer to produce sufficient yield required for effective capture of landfill constituents in this area. The 5-gpm pumping requirement for the fourth well to the east is minimal and is not expected to be difficult to obtain. Additionally, this fourth well introduces the possibility of pulling additional contaminants into the eastern flow path. Currently, wells located to the east of the golf course do not show evidence of landfill contamination. Installing and pumping a well in this region would pull water in this direction and could actually spread the contamination. For these reasons, the initial phase of testing focused on the western portion of the site.

3.0 FIELD INVESTIGATION

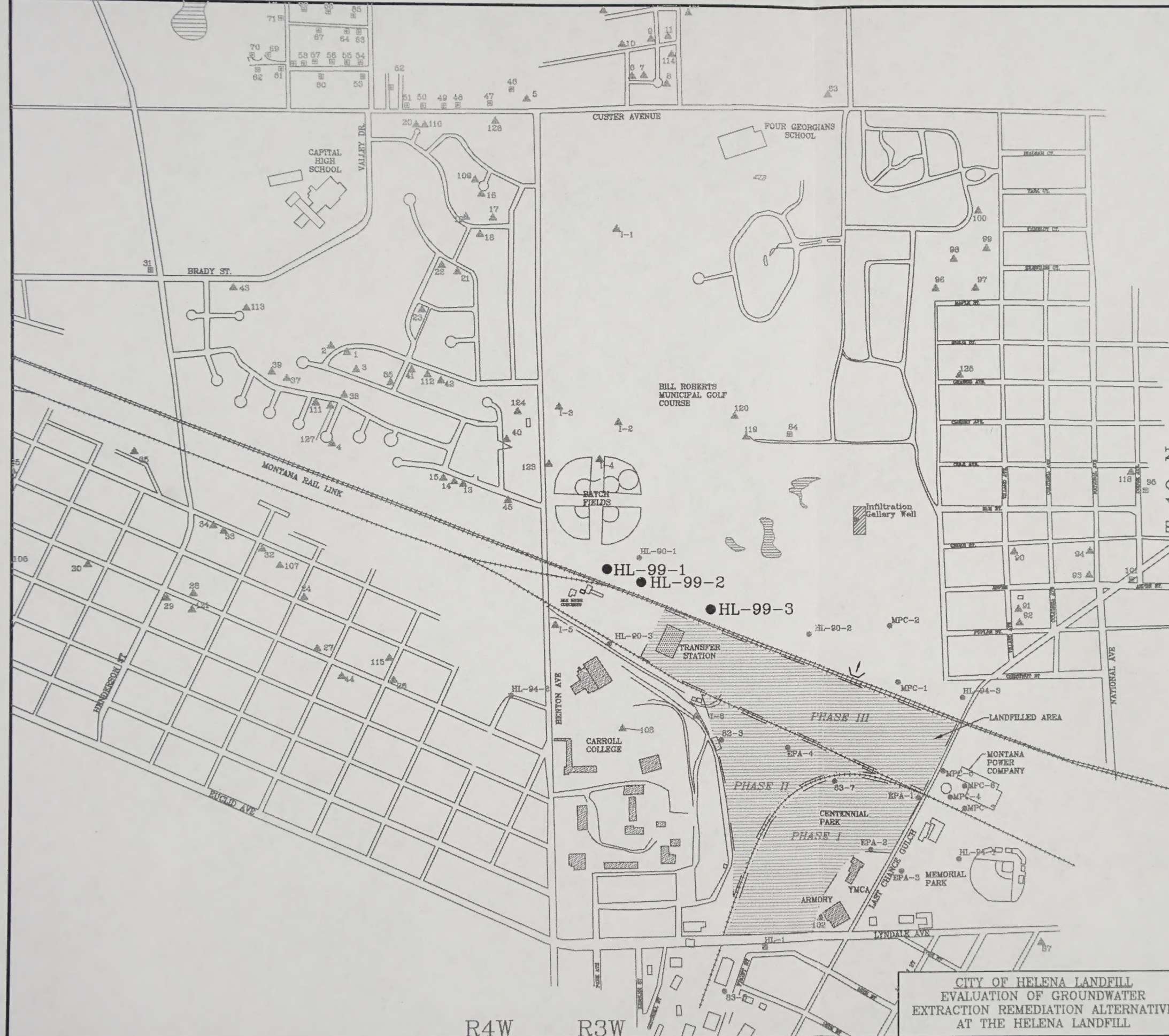
The field investigation consisted of the installation and development of three groundwater recovery wells, short-term pumping tests (3-4 hours) on these wells and water quality sampling for volatile organic compounds (VOCs). The field procedures and findings for each of these tasks are described below. The locations of the installed wells, designated HL-99-1, HL-99-2 & HL-99-3, are shown in Figure 3-1. Figure 3-2 shows the geology, static water levels and the well completion intervals for all three wells.

3.1 WELL INSTALLATION

The approximate locations for the proposed recovery wells were determined from the hydrologic modeling analysis and finalized in the field based on utility and access constraints. H&L Drilling of Helena, Montana drilled the wells using a forward rotary drill rig with a top drive-casing hammer. A Hydrometrics' hydrogeologist and licensed monitoring well constructor was present during drilling to log the geology and finalize well completion intervals. The boreholes were initially advanced to the total depth at each location to collect information on stratigraphy, water yield and specific conductivity (SC) of the groundwater with depth. SC is a general measure of the number of ions in solution and was used to detect general changes in groundwater quality with depth. Hydrometrics consulted with MDEQ representatives prior to finalizing the well completion depths and screened intervals.

3.1.1 Extraction Well HL-99-2

Drilling began on June 16, 1999 at the middle well (HL-99-2). A 6-inch diameter boring was advanced to the proposed completion depth of 120 feet. Groundwater was encountered at approximately 60 feet. The geology consisted of gravelly sand with some finer intervals of gravelly, clayey sand. No bedrock was encountered at this location. A well log containing a detailed description of the site stratigraphy is included in Appendix B. SC measurements were taken at various depths during drilling and decreased from 1,017 $\mu\text{mhos/cm}$ at a depth of 70 feet to 670 $\mu\text{mhos/cm}$ at a depth of 120 feet, indicating that groundwater quality probably improves with depth. SC trends with depth are depicted in Figure 3-3.



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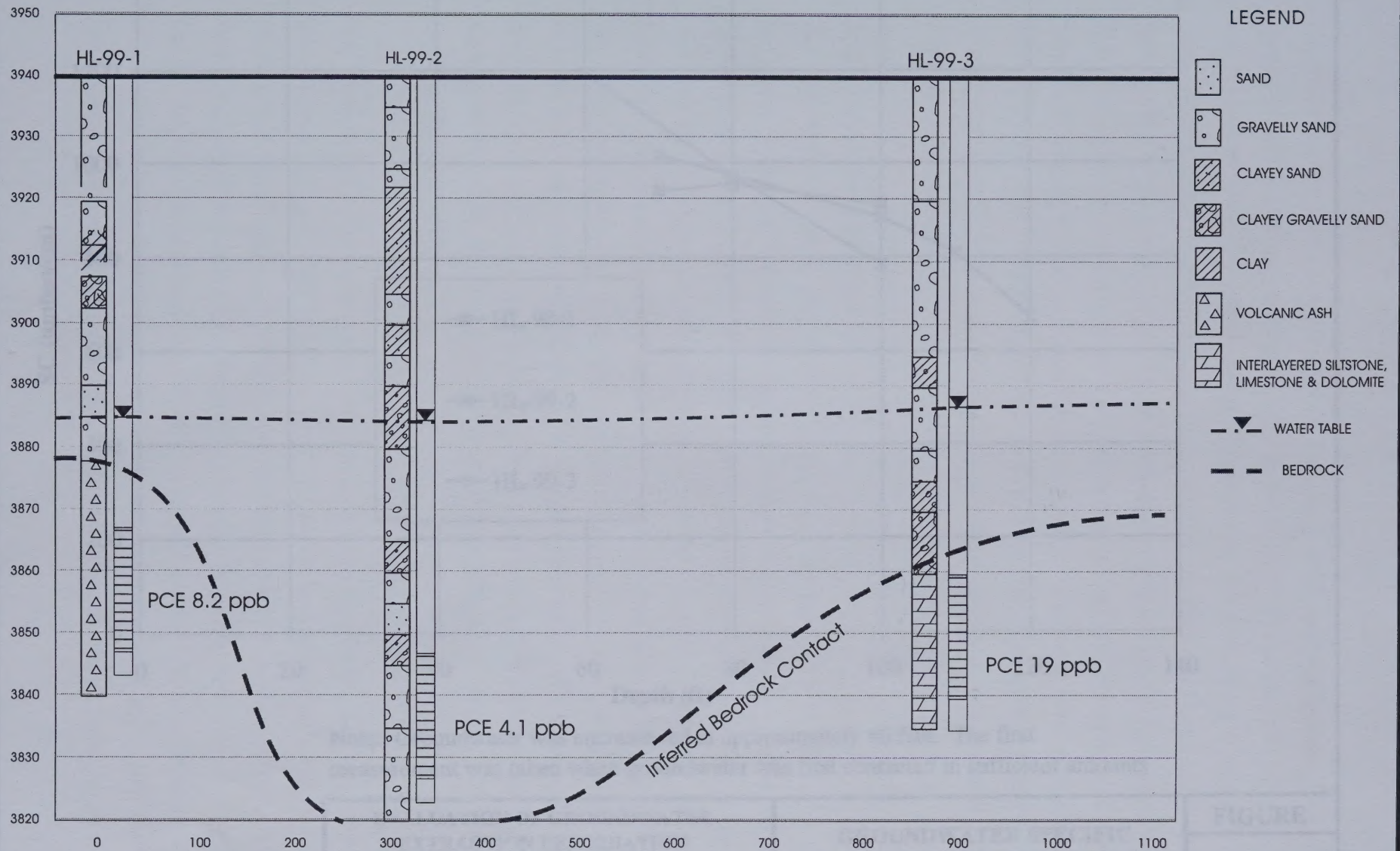
- FL-1 ■ PIEZOMETER
- 83-8 ● MONITORING WELL
- I-6 ▲ IRRIGATION WELL
- 80 □ DOMESTIC WELL
- HL-99--2 ● EXTRACTION WELL
-  INFILTRATION GALLERY (GROUNDWATER COLLECTION SYSTEM)
- ↓
STORM WATER OUTFALL FOR LAST CHANCE GULCH

CITY OF HELENA LANDFILL
EVALUATION OF GROUNDWATER
EXTRACTION REMEDIATION ALTERNATIVE
AT THE HELENA LANDFILL

LOCATION OF GROUNDWATER EXTRACTION WELLS

FIGURE
3-1

HELENA LANDFILL GROUNDWATER RECOVERY TEST WELLS



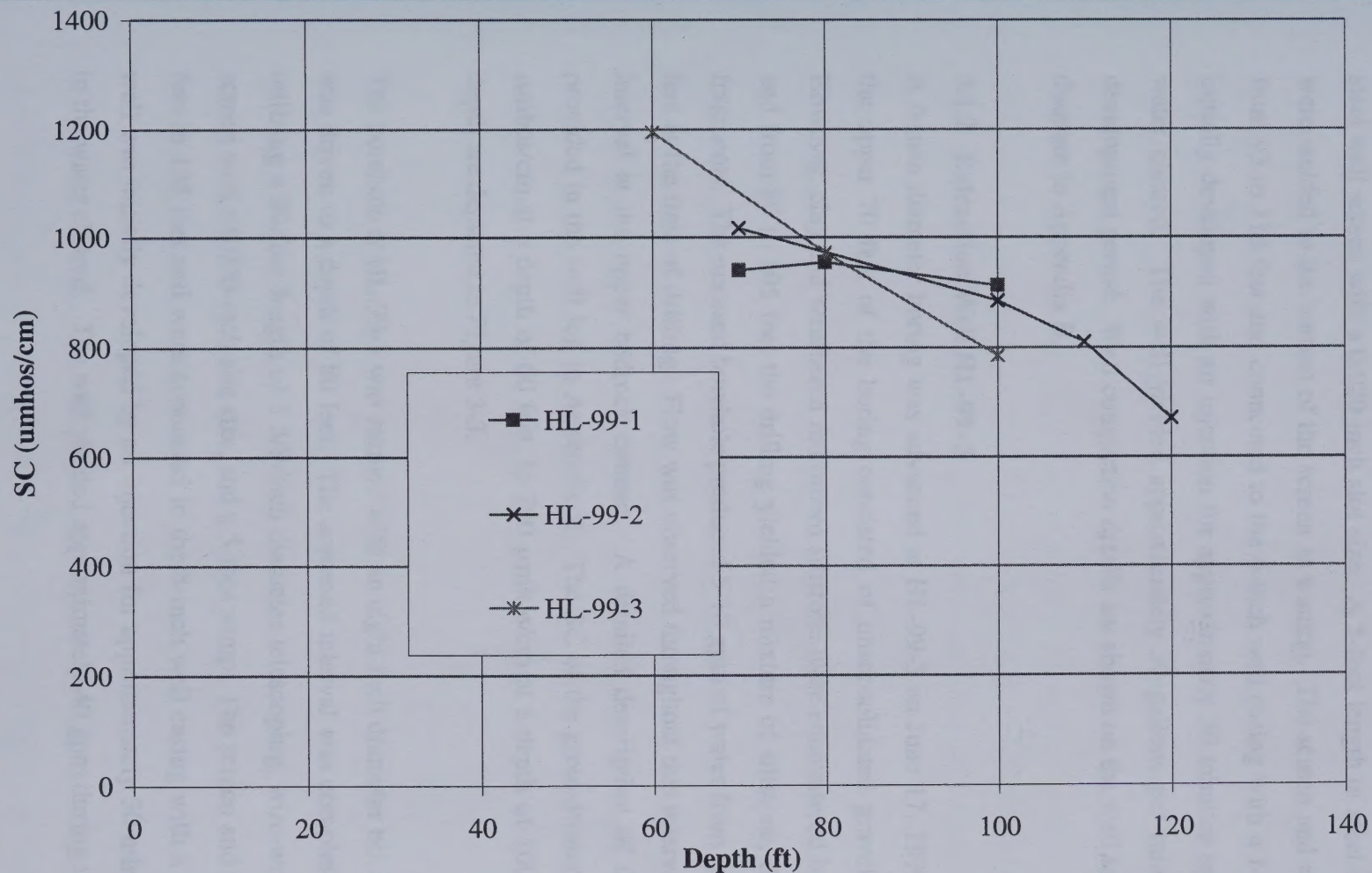
Note: Reported PCE concentrations are from sampling on 6/28/99.

**EVALUATION OF GROUNDWATER
EXTRACTION REMEDIATION ALTERNATIVE
AT THE HELENA LANDFILL
HELENA, MONTANA**

**CROSS SECTION SHOWING
SITE STRATIGRAPHY AND
WELL COMPLETION DATA**

FIGURE

3-2



Note: Groundwater was encountered at approximately 60 feet. The first measurement was taken when groundwater was first contacted in sufficient amounts to sample.

EVALUATION OF GROUNDWATER
EXTRACTION REMEDIATION
ALTERNATIVE
AT THE HELENA LANDFILL
HELENA, MONTANA

GROUNDWATER SPECIFIC
CONDUCTIVITY VERSUS DEPTH
AT TIME OF DRILLING

FIGURE

3-3

Six-inch diameter steel casing was driven to a depth of 93 feet at HL-99-2. The remaining borehole was then reamed to 8-inches prior to setting the well screen. The screened interval was completed using a 20-foot length of 5 5/8-inch diameter telescoping, wire-wrap, stainless steel well screen with a 0.020-inch slot size. A 5-foot length of steel casing with an end cap were welded to the bottom of the screen as a sump. The screen and sump assembly was set from 93 to 118 feet and connected to the 6-inch well casing with a J-packer. The well was initially developed with air injection for approximately 30 minutes until the turbidity in the water cleared. The well yielded approximately 30 gallons per minute (gpm) during this development period. Well completion details are shown on the well log and well completion diagram in Appendix B.

3.1.2 Extraction Well HL-99-3

A 6-inch diameter boring was advanced at HL-99-3 on June 17, 1999. The stratigraphy in the upper 70 feet of the boring consisted of unconsolidated gravels similar to HL-99-2. However, clay and weathered red/brown siltstone were encountered between 70 and 80 feet, and from 80 to 105 feet the drilling yielded a mixture of siltstone, dolomite and limestone fragments. The uncased borehole produced 5-10 gpm of water from approximately 65 to 105 feet at the time of drilling. Flow was observed throughout this interval including the clayey interval at the upper bedrock contact. A detailed description of the site stratigraphy is provided in the well log in Appendix B. The SC of the groundwater decreased from 1,170 $\mu\text{mhos/cm}$ at a depth of 60 feet, to 790 $\mu\text{mhos/cm}$ at a depth of 100 feet. SC trends with depth are depicted in Figure 3-3.

The borehole at HL-99-3 was reamed with an eight-inch diameter bit, and 8-inch steel casing was driven to a depth of 80 feet. The screened interval was completed similar to HL-99-2, utilizing a 20-foot length of 5 5/8-inch diameter telescoping, wire-wrap, stainless steel well screen with a 0.020-inch slot size, and a 5-foot sump. The screen and sump were set from 80 feet to 105 feet and were connected to the 8-inch well casing with a neoprene packer. The well was initially developed by air injection for approximately 30 minutes until the turbidity in the water cleared. The well yielded approximately 40 gpm during this initial development

period. Well completion details are shown on the well log and well completion diagram in Appendix B.

3.1.3 Extraction Well HL-99-1

A 6-inch diameter boring was advanced at HL-99-1 on June 17, 1999. The stratigraphy of the upper 60 feet consisted of unconsolidated gravels similar to HL-99-2. However, light gray volcanic ash deposits containing angular lithic fragments of mixed lithologies were encountered at approximately 65 feet and continued to the depth of completion at 100 feet. A detailed description of the site stratigraphy is provided in the well log in Appendix B. The uncased boring produced more than 10 gpm of water at the time of drilling. Most of this water was encountered from 70 to 90 feet. The specific conductance of the water at HL-99-1 was 940 $\mu\text{mhos/cm}$ at 70 feet and showed little variation with increasing depth (see Figure 3-3).

The borehole at HL-99-1 was reamed with an eight-inch diameter bit and 8-inch steel casing was driven to a depth of 40 feet where casing refusal was met. Five-inch steel casing was used to complete the well. The 5-inch casing was welded directly to 20 feet of stainless steel wire-wrap well screen and a 5-foot sump was welded to the bottom. The screen and sump were set from 73 feet to 98 feet. The well was developed with air injection for approximately 30 minutes until the turbidity in the water cleared. The well yielded approximately 40 gpm during development. Well completion details are shown on the well log and well completion diagram in Appendix B.

3.2 AQUIFER TESTING

3.2.1 Methodology

Individual, short-term pumping tests, 3 to 4 hours in duration, were conducted at each of the recovery wells. Prior to testing, the wells were sampled for VOCs. The sampling methodology and results are discussed in Section 3.3, Groundwater Sampling.

At each site, the pumping well was instrumented with a 4-inch submersible pump installed immediately above the screened interval of the well. Power was supplied to the pump by a

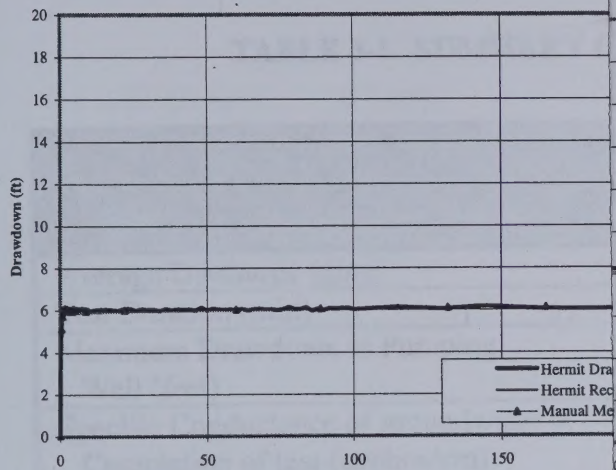
portable generator. A foot valve was installed in the discharge line above the pump to prevent the line from draining back into the well at the conclusion of the test. This allowed representative water level recovery data to be collected. A two-inch discharge hose was used to carry the water approximately 200 feet from the wellhead where it was sprayed upward through a high-pressure discharge nozzle to optimize volatilization of VOCs. A sampling port was installed in the discharge line at the wellhead and flow meters were installed in-line to monitor discharge rates. An In-situ Hermit datalogger and pressure transducer were installed in the pumping well to record water level fluctuations during the test.

Prior to testing, static water level measurements were taken manually in the pumping well and in surrounding observation wells with a Solinst water level indicator. The wells were pumped briefly to allow the discharge lines to fill with water and to adjust the discharge rate for the test. Water levels in the pumping well were allowed to recover prior to starting the pumping test. Manual water level measurements were taken in the pumping well during the test to confirm the datalogger readings. Manual measurements were also taken in surrounding monitoring wells HL-90-1, HL-90-2 and HL-90-3, and in the adjacent recovery wells to evaluate the extent of drawdown effects. Flow rates and SC measurements from the pumping well were also recorded at regular intervals. The pumping tests were run for 3 to 4 hours until drawdown began to stabilize. A VOC sample was collected from each well at the completion of the pumping test. The datalogger was restarted at the end of the test and used to record recovery data.

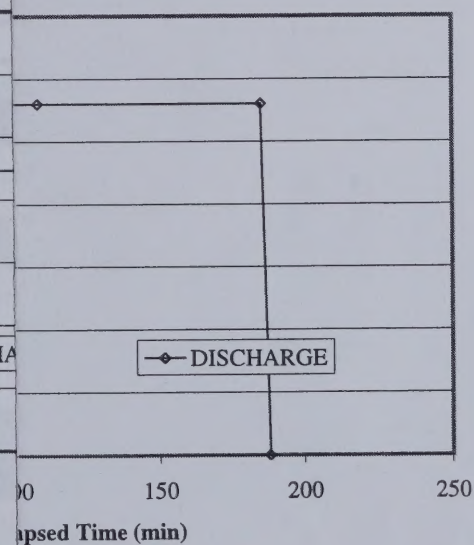
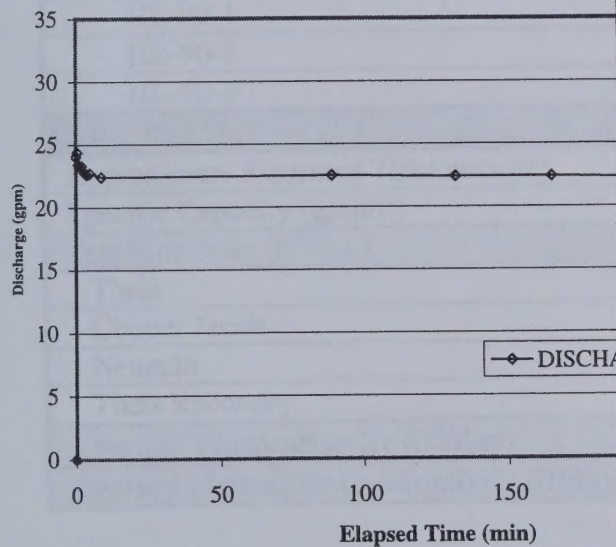
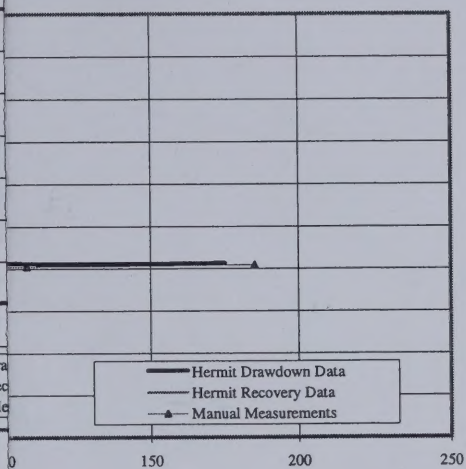
3.2.2 Results

Pumping rates, drawdown observations and SC results for each of the tests are summarized in Table 3-1. Graphs of the drawdown data are shown in Figure 3-4 and a complete listing of the pumping test results is in Appendix B. The data were analyzed to determine aquifer transmissivity and hydraulic conductivity using standard curve matching techniques. The program Aqtesolv was used to generate drawdown curves and conduct the curve-matching

HL99-1 PUMPING TEST RESULTS



HL99-3 PUMPING TEST RESULTS

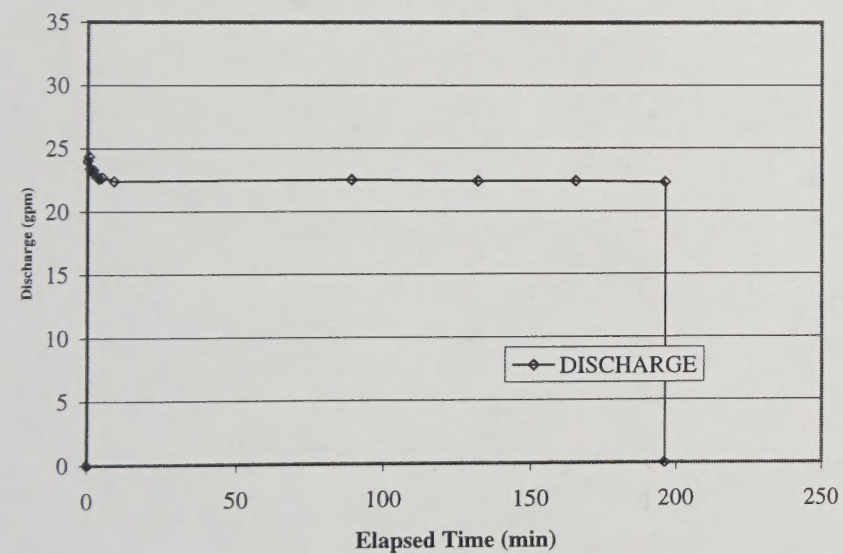
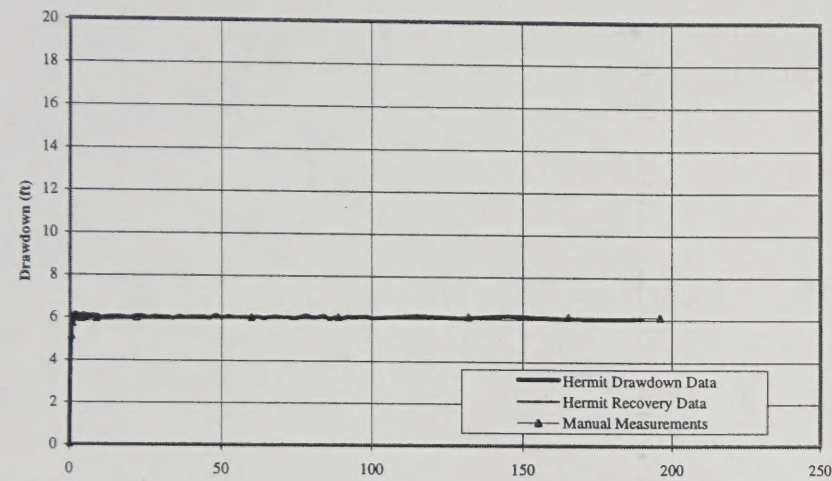


CHARGING AQUIFER TEST
DISCHARGE RESULTS

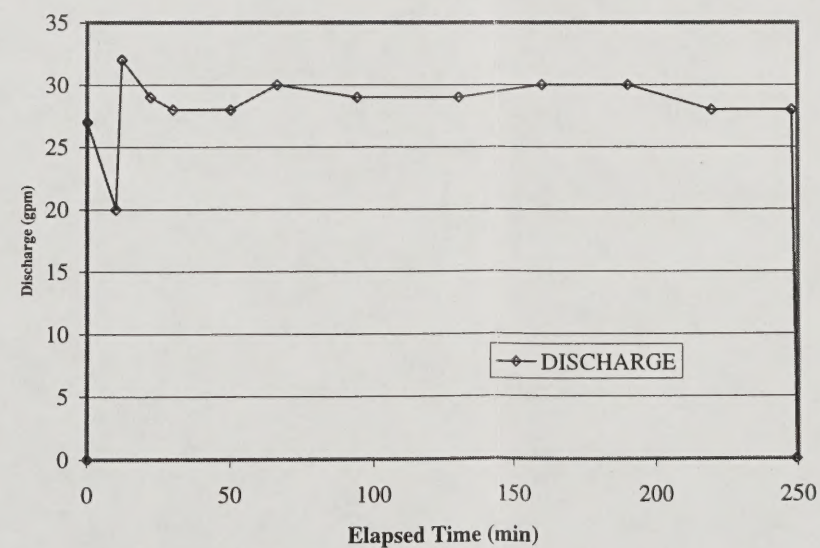
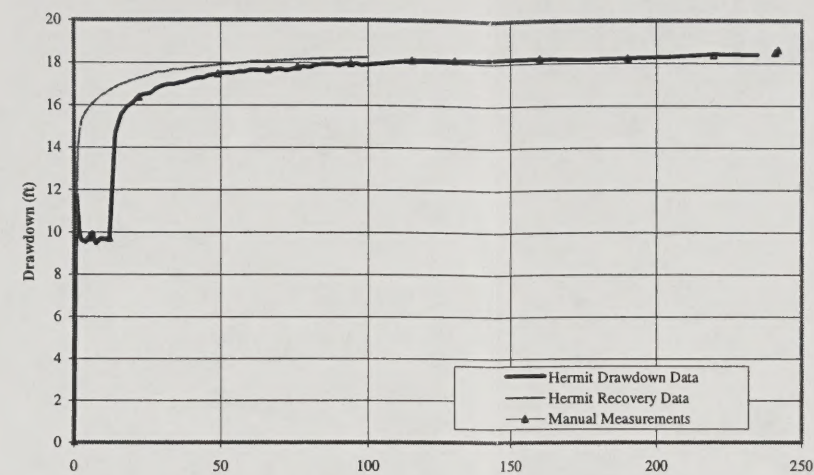
FIGURE

3-4

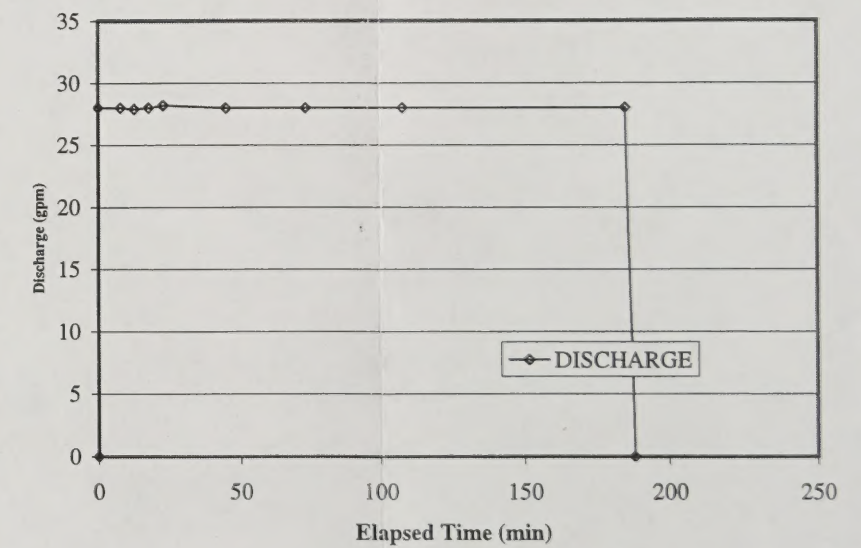
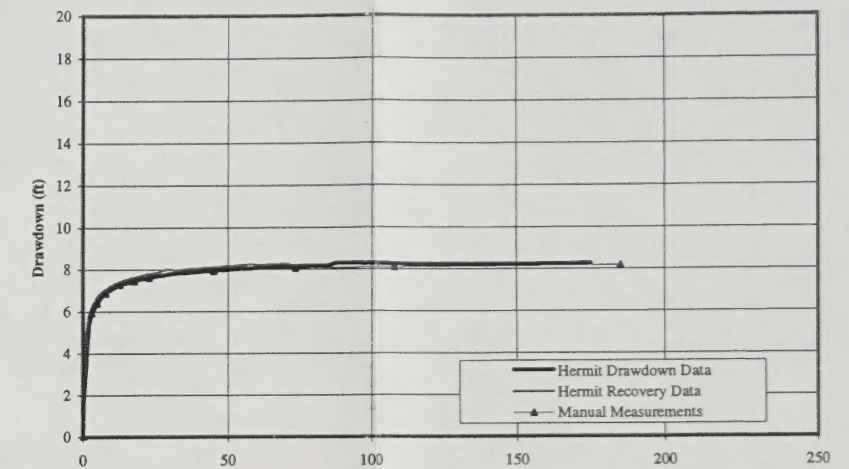
HL99-1
PUMPING TEST RESULTS



HL99-2
PUMPING TEST RESULTS



HL99-3
PUMPING TEST RESULTS



EVALUATION OF GROUNDWATER
EXTRACTION REMEDIATION ALTERNATIVE
AT THE HELENA LANDFILL
HELENA, MONTANA

GRAPHS SUMMARIZING AQUIFER TEST
DRAWDOWN AND DISCHARGE RESULTS

FIGURE

3-4

analyses. The results of the analyses are summarized in Table 3-1. Aqtesolv graphs and analytical results are included in Appendix B.

TABLE 3-1. SUMMARY OF AQUIFER TEST RESULTS

PARAMETER	PUMPING WELL		
	HL-99-1	HL-99-2	HL-99-3
Measured Data			
Average Discharge (gpm)	23	28	28
Test Duration (min)	196	248	188
Maximum Drawdown in Pumping Well (feet)	6.13	18.62	8.17
Specific Conductance of groundwater at Completion of test ($\mu\text{mhos/cm}$)	950	899	841
Maximum Drawdown in Observation Wells (feet)			
HL-99-1	--	0.14	0.03
HL-99-2	0.05	--	0.16
HL-99-3	-0.06	0.11	--
HL-90-1	0.00	0.04	0.00
HL-90-2	0.00	0.03	0.05
HL-90-3	0.03	0.00	0.00
Calculated Data			
Approximate Saturated Thickness (ft)	40	60	50
Specific Capacity (gpm/ft)	3.8	1.5	3.4
Transmissivity (ft^2/day)			
Theis	196	108	258
Cooper Jacob	174	87	242
Neuman	154	122	264
Theis Recovery	145	75	208
Average Transmissivity (ft^2/day)	167	98	243
Average Hydraulic Conductivity (ft/day)	4.2	1.6	4.9

Water level drawdown and recovery trends at wells HL-99-2 and HL-99-3 are consistent with drawdown curves for an unconfined aquifer system (see Neuman curve matches in Appendix B). HL-99-1 showed a slightly different drawdown trend than the other two wells (Figure 3-4). There was a large amount of instantaneous drawdown at HL-99-1 and then water levels stabilized rapidly. Water level recovery showed similar trends. This type of response may reflect formation loss, where there is head loss within the aquifer due to high

flow velocities. Formation loss sometimes occurs in bedrock aquifers if flow is localized within a few fractures. This scenario is consistent with the well geology and the observed discharge quality and flow during well completion.

3.3 GROUNDWATER SAMPLING

An initial sample from well HL-99-2 was collected on June 18, 1999. Two sets of additional groundwater samples were collected from all three wells. The first set, collected on June 28, 1999, was collected after all the wells had been completed and developed, but prior to aquifer testing. The second set, collected July 8-12, 1999, were collected during aquifer testing. These samples were collected to evaluate the water quality that will be encountered with long-term pumping to provide information for full-scale design. All samples were analyzed for VOCs.

3.3.1 Methodology

3.3.1.1 Initial Sampling of HL-99-2

The initial sample was collected from well HL-99-2 on June 18, 1999 after the casing was installed but before the well was completed or developed. A 2-inch Grundfos Rediflow submersible pump was used to purge the well at 3-5 gpm for 30 minutes. A sample was then collected in a 40-ml glass vial directly from the pump hose. Considerable care was taken to minimize air entrainment and to ensure a zero-headspace sample. The sample was immediately taken to Alpine Analytical, Inc. in Helena, Montana and analyzed for VOCs that same day.

3.3.1.2 Sampling Prior to Aquifer Testing

Groundwater samples were collected from each of the three extraction wells on June 28, 1999 after the wells had been completed and developed. Static water level measurements were collected prior to sampling. A 4-inch submersible pump was used to purge a minimum of three bore volumes from each well before a sample was collected in a disposable bailer. All purge water was collected in a waste tank and delivered to the sanitary sewer for disposal. Two samples were collected from each well in 40-ml glass vials and preserved with hydrochloric acid. Water sampling forms completed during sampling are included in

Appendix C. Considerable care was taken to minimize air entrainment and to ensure a zero-headspace sample. The samples were sent to Energy Laboratories in Billings, Montana for analysis.

3.3.1.3 Sampling During Aquifer Testing

Groundwater samples were again collected from each of the three extraction wells on July 8, 9, and 12, 1999 during aquifer testing. At the conclusion of each pumping test but prior to the well recovery analysis, a water quality sample was collected from the sample port located at the well head. Two samples were collected from each well in 40-ml glass vials and preserved with hydrochloric acid. Considerable care was taken to minimize air entrainment and to ensure a zero-headspace sample. The samples were sent to Energy Laboratories in Billings, Montana for analysis.

3.3.2 Results

3.3.2.1 Initial Confirmation Sample

The sample collected from well HL-99-2 on June 18, 1999 and analyzed for VOCs by Alpine Analytical, Inc. initially detected tetrachloroethene (PCE) at a concentration of 240 mg/L. No other VOCs were detected. This result was substantially higher than expected based on the downgradient monitoring well HL-90-1 (<20 mg/L). The lab was contacted to reanalyze the sample. Meanwhile, it was agreed in subsequent conversations with representatives of MDEQ and the City of Helena that a set of samples would be collected after all three wells were completed and developed to confirm this initial sample and to help determine disposal options during aquifer testing. The reanalysis of the initial water sample from HL-99-2 indicated a PCE concentration of 4.2 mg/L, well within the expected range from surrounding wells. A copy of the analysis is included in Appendix C.

3.3.2.2 Samples Collected Prior to Aquifer Testing

Samples collected from wells HL-99-1, HL-99-2, and HL-99-3 on June 28, 1999 and analyzed for VOCs by Energy Laboratories contained PCE at concentrations of 8.2 mg/L, 4.1 mg/L and 19 mg/L, respectively. Concentrations of several other typical landfill contaminants (dichlorofluoromethane, 1,1-dichloroethane, cis-1,2-dichloroethene, etc.) were

also recorded, all at level less than the MCLs. Copies of these analyses are included in Appendix C. These results were consistent with concentrations of similar compounds previously detected in nearby monitoring well HL-90-1. It was agreed in subsequent conversations and meetings with representatives from the MDEQ and the City of Helena that based on the results of these samples, water extracted during aquifer testing could be surface discharged after simple single-stage aeration (i.e., sprayed through a fine stream spray nozzle).

3.3.2.3 Samples Collected During Aquifer Testing

Samples collected from extraction wells HL-99-1 (July 12, 1999), HL-99-2 (July 8, 1999) and HL-99-3 (July 9, 1999) during aquifer testing and analyzed for VOCs by Energy Laboratories contained PCE at concentrations of 7.8 mg/L, 5.8 mg/L and 24 mg/L, respectively. Copies of these analyses are included in Appendix C. These results will be used to determine discharge treatment options in the final detailed design.

4.0 COMPARISON WITH THE ORIGINAL MODEL

The findings from the field investigation were generally consistent with the initial capture zone analysis with a few exceptions:

- Bedrock was encountered at shallower depths than anticipated at HL-99-1 and HL-99-3. Based on water level and water quality data, the upper portion of the bedrock aquifer at both of these wells is in indirect communication with the alluvial groundwater system and contains similar levels of landfill constituents. A groundwater extraction alternative is still potentially feasible with the observed site conditions.
- Aquifer permeability is somewhat lower than the initial assumptions used to evaluate this alternative. The field data indicate that hydraulic conductivities range from approximately 2 to 5 feet/day in the vicinity of the recovery wells versus 10 to 20 feet/day used in the initial modeling analysis.

Additional calculations were performed to evaluate whether this decrease in permeability significantly alters the potential capture effectiveness of the recovery wells. The capture zones were calculated using an analytical groundwater flow model based on the average hydraulic conductivity from the field investigation. The results, shown in Figure 4-1, indicate an increase in drawdown compared to the original capture scenario. As a result, the capture area is expanded, with the majority of flow from the landfill captured by HL-99-3 and HL-99-2. Model inputs and outputs are included as Appendix D.

The water levels, geology, and VOC concentrations encountered in the field are consistent with the previous analysis and confirm that constituents from the landfill travel northwest along a relatively narrow flow path. The geology, although more variable than originally assumed, is still suitable for a groundwater extraction alternative. The necessary yields predicted by the groundwater flow model (approximately 20 to 30 gallons per minute) were achieved at each of the recovery wells resulting in significant zones of capture. While



EVALUATION OF GROUNDWATER
EXTRACTION REMEDIATION ALTERNATIVE
AT THE HELENA LANDFILL
HELENA, MONTANA

CALCULATED CAPTURE ZONE
BASED ON RECOVERY
TEST RESULTS

FIGURE

4-1

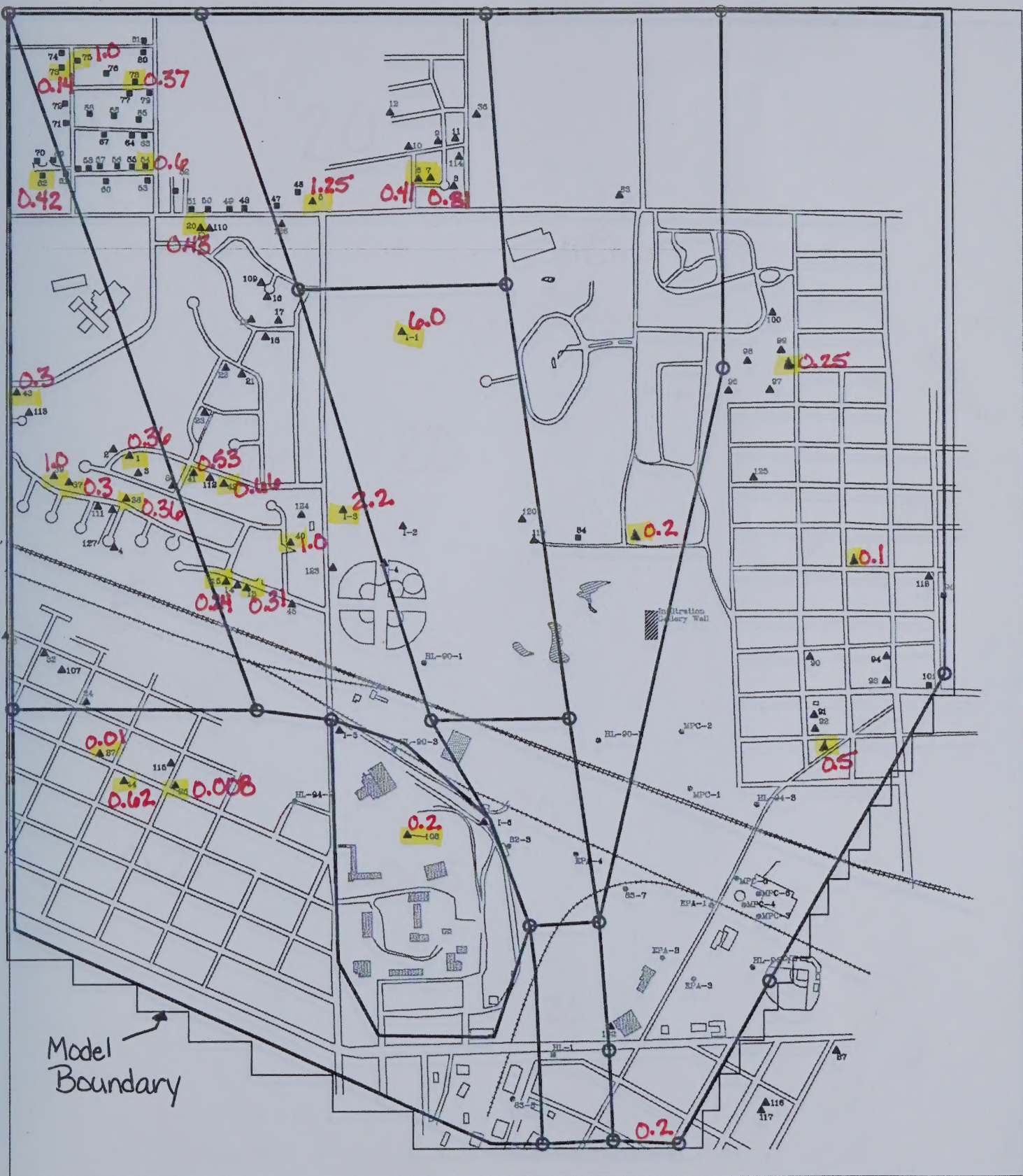
the presence of a bedrock groundwater flow system makes it more difficult to accurately characterize the capture zone boundaries, the field observations during testing were generally consistent with the model predictions. The capture zone effectiveness will need to be evaluated during operational monitoring of the recovery wells.

5.0 CONCLUSIONS AND RECOMMENDATIONS

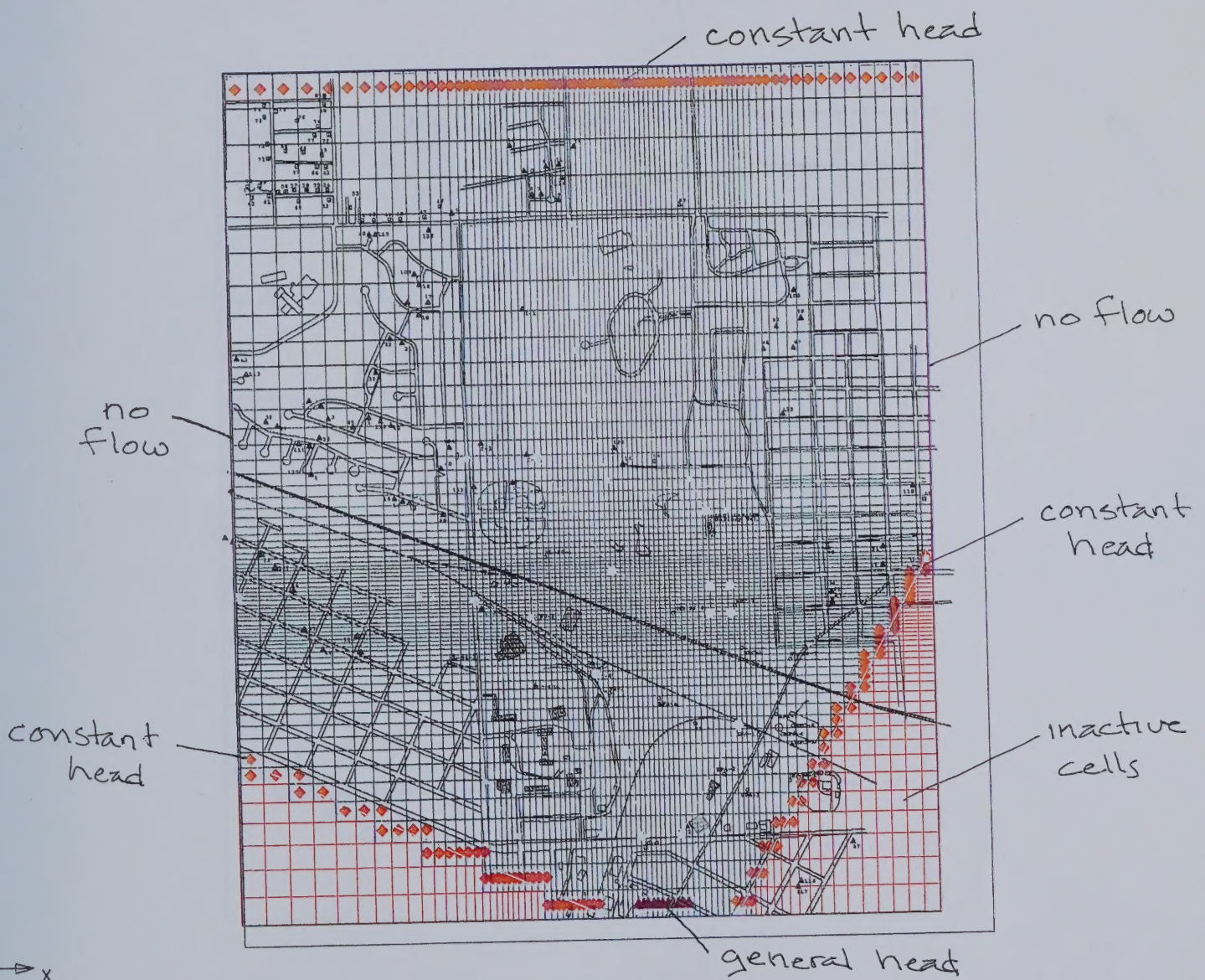
Based on the results of the field investigation and computer modeling of the groundwater system, it appears that groundwater extraction is a viable option for groundwater remediation at the Helena Landfill. The results of this investigation indicate that the three wells installed during this investigation are sufficient to proceed with extended operational testing. Monitoring data from this next phase of work will establish whether these wells can effectively decrease downgradient levels of PCE below the MCL, or whether additional wells, including the one pumping well to the east used in the computer model, are necessary. Concentrations of VOCs in the pumping wells are sufficiently low (an average of 12.6 mg/L at the flows pumped during aquifer testing) that simple single-stage aeration (i.e., spraying) prior to land application should provide adequate treatment to reduce concentrations below the MCL prior to discharge. However, monitoring should be conducted to confirm this. The results of this investigation indicate modifying the Corrective Measures Assessment to incorporate a groundwater extraction alternative as the preferred corrective action is appropriate. Detailed design of the system should be completed as soon as possible to facilitate installation of the system before the start of the year 2000 irrigation season.

APPENDIX A

SELECTED HYDROLOGIC MODEL INPUTS AND OUTPUTS



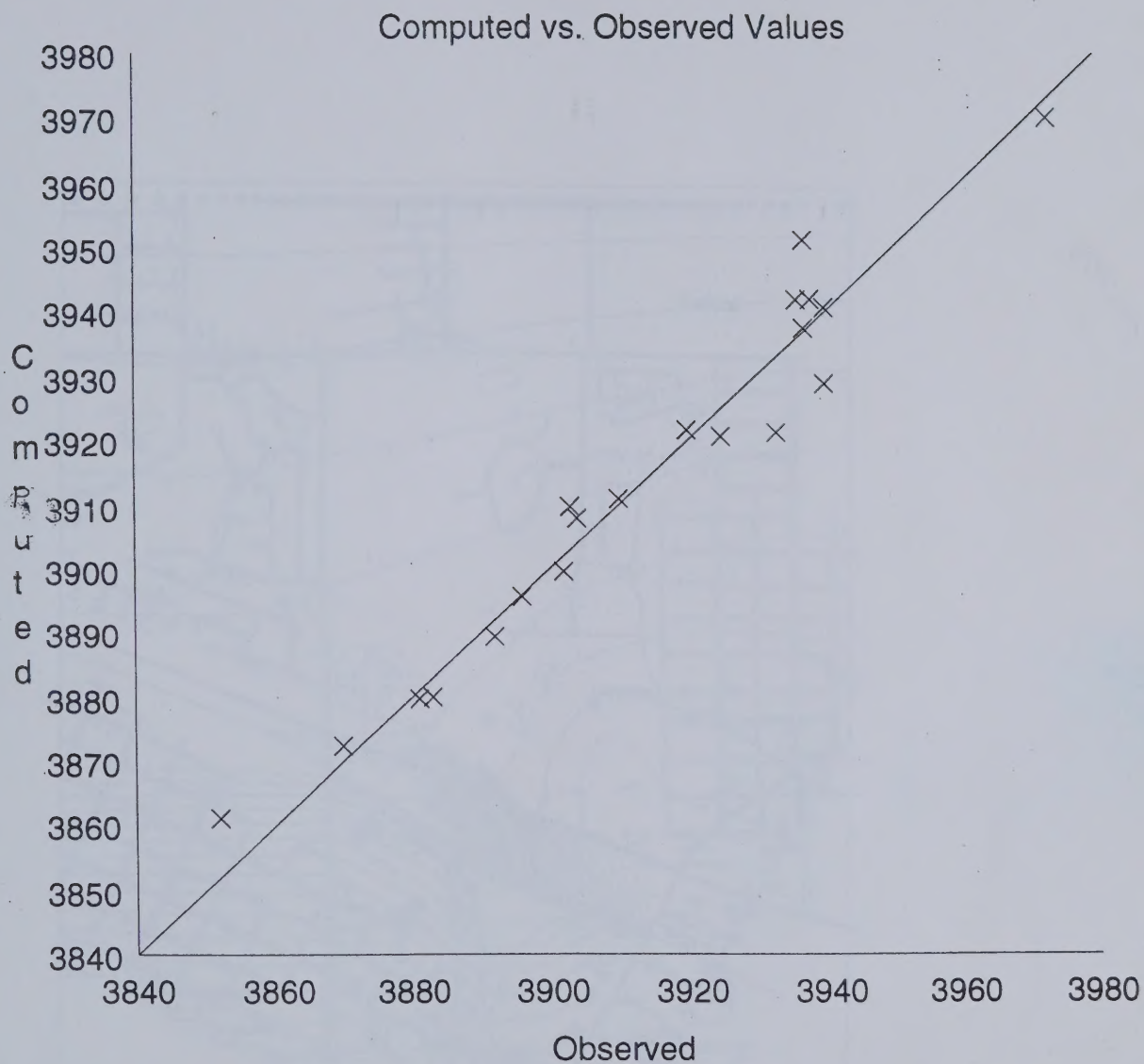
SPECIFIC CAPACITY DATA
SOURCE: WELL LOGS



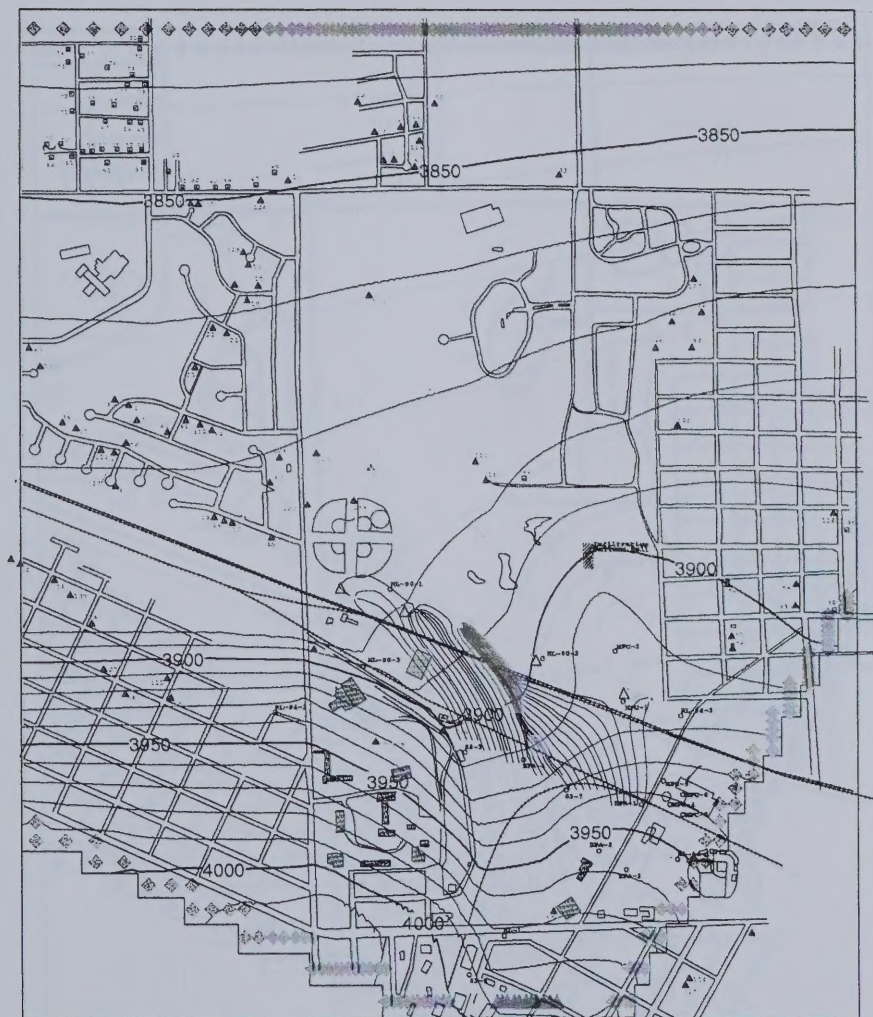
Model Grid and Boundary Conditions



Model Calibration Run showing Steady State
Water Table and Particle Flow Paths
From Landfill



Comparison of Model Results
vs. Observed Water Levels



Steady State Capture Well
Simulation



Seasonal Operation of Capture
Wells

STANDARD OPERATING PROCEDURE FORM

AQUICLIX TEST DATA FORM

HP 10001-00

Well Name: Well 100-100 Date: 10/1/80 Operator: Bill Thompson

Well ID: 100-100 Well Type: 100-100 Well Depth: 100 ft

Well Location: 100-100 Well Status: 100-100 Well Notes: 100-100

Well Construction: 100-100 Well Completion: 100-100 Well Production: 100-100

Well Test Results: 100-100 Well Test Date: 10/1/80 Well Test Time: 10:00 AM

Well Test Method: 100-100 Well Test Equipment: 100-100 Well Test Operator: 100-100

Well Test Results: 100-100 Well Test Date: 10/1/80 Well Test Time: 10:00 AM

Well Test Method: 100-100 Well Test Equipment: 100-100 Well Test Operator: 100-100

Well Test Results: 100-100 Well Test Date: 10/1/80 Well Test Time: 10:00 AM

APPENDIX B

WELL LOGS AND DRAWDOWN CURVES

Time	Flow	Pressure	Drawdown	Flow	Pressure	Drawdown
7:00	100	100	100	100	100	100
7:05	100	100	100	100	100	100
7:10	100	100	100	100	100	100
7:15	100	100	100	100	100	100
7:20	100	100	100	100	100	100
7:25	100	100	100	100	100	100
7:30	100	100	100	100	100	100
7:35	100	100	100	100	100	100
7:40	100	100	100	100	100	100
7:45	100	100	100	100	100	100
7:50	100	100	100	100	100	100
7:55	100	100	100	100	100	100
8:00	100	100	100	100	100	100
8:05	100	100	100	100	100	100
8:10	100	100	100	100	100	100
8:15	100	100	100	100	100	100
8:20	100	100	100	100	100	100
8:25	100	100	100	100	100	100
8:30	100	100	100	100	100	100
8:35	100	100	100	100	100	100
8:40	100	100	100	100	100	100
8:45	100	100	100	100	100	100
8:50	100	100	100	100	100	100
8:55	100	100	100	100	100	100
9:00	100	100	100	100	100	100
9:05	100	100	100	100	100	100
9:10	100	100	100	100	100	100
9:15	100	100	100	100	100	100
9:20	100	100	100	100	100	100
9:25	100	100	100	100	100	100
9:30	100	100	100	100	100	100
9:35	100	100	100	100	100	100
9:40	100	100	100	100	100	100
9:45	100	100	100	100	100	100
9:50	100	100	100	100	100	100
9:55	100	100	100	100	100	100
10:00	100	100	100	100	100	100

STANDARD OPERATING PROCEDURE FORM

AQUIFER TEST DATA FORM®

HF-FORM-400

Project Helena Landfill 0054 Personnel Dave Sitch, Bill Thompson
 Well Observed HL-99-1 Well Tested HL-99-1 Test Date 7-12-99

Well Description

State MT County LAC Location: T R Sec. Tract
 Borehole Dia. (in) 8" Well Dia. (in) 5" Well Depth (ft) 98'
 Perforated Zone(s) (ft) 73-93' Desc. of MP top of 5" steel Stick-up (ft) 1.57'
 SWL below MP (ft) 58.81' SWL below GS (ft) 56.44'
 Aquifer Name Aquifer Description

Test Description

Test Type: 1 Pumping Well Drawdown 3. Observation Well Drawdown 5. Slug Injection 7. Other
 (circle one) 2. Pumping Well Recovery 4. Observation Well Recovery 6. Bailor Recovery

Distance of Observation Well from Pumping Well (ft) 0.2' Pump hp. & type 2hp zerometer
 Pump Depth (ft) 72' Water Quality Sample Taken? yes no
 Specific Conductance (umhos/cm @25 C) 950 Temp (C) 55 Avg. Discharge (gpm) 22.5 gpm
 Test Duration (min) 201 Max WL Change (ft) 6.13' Transmissivity (gpd/ft)
 Storativity Hydraulic Conductivity (gpd/ft)
 Specific Capacity (gpm/ft of drawdown) REMARKS

Date	Time			Temp	SC	
7/12/99	1033	56.67				
	1051	58.01	static			
	1105		pump on			
	1106 ³⁰		17.5 gpm			
	11:07:03	62.40'				
	11:09:00	62.45'	17.4 gpm			
	11:13:10		20.4 gpm	63	820	
	11:14:00		22.5 gpm			
	11:15:05		shut pump off	58.08		
→	1125	58.07	58.07			
	1125:32	63.20	24.4 gpm			
	1125:58	63.80	23.4 gpm			
	1127:00	64.14	23.3 gpm			
	1128:00	64.06	22.8 gpm			
	1129:00	64.03	22.6 gpm			
	1130:00	64.07	22.7 gpm	54.6	908	
	1134:00	64.03	22.5 gpm			

Start Test

1147	64.07		55.0	927	1446:31	59.60'
1225	64.10		57.5	960	1446:51	58.40'
1254	64.13	22.5 gpm	56.5	950	1447:29	58.32'
1337	64.39	22.4 gpm	54.8	944	1448:19	58.30'
1410	64.20	22.4 gpm	54.5	938	1453:30	58.25'
1441	64.20	22.3 gpm	55.0	950	1511:33	58.19'
1446:17	60.50				1530:00	58.17'
					1553:00	58.15'
					1608	58.15'

Stop Test

Project 0054 Personnel D.S. & L Test Date 7/12/89
Well Observed HL-99-3 Well Tested HL-99-1

[illegible]

Project 0054 Personnel D.S. Lee Test Date 7/12/58
Well Observed HL-99-2 Well Tested HL-99-1

[illegible]

Project 0054 Personnel DS. tch Test Date 7/12/89
Well Observed HL 90-1 Well Tested HL-88-1

[illegible]

AQUIFER TEST DATA (Cont.)

Project 0054 Personnel D. S. Tech Test Date 7/12/99
Well Observed HL-90-3 Well Tested HL-99-1

[illegible]

AQUIFER TEST DATA (Cont.)

Project _____ Personnel _____ Test Date _____
Well Observed _____ Well Tested _____

[illegible]

AQUIFER TEST DATA (Cont.)

Project _____ Personnel _____ Test Date _____
Well Observed _____ Well Tested _____

[illegible]

AQUIFER TEST DATA (Cont.)

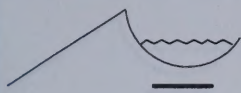
Project _____ Personnel _____ Test Date _____
Well Observed _____ Well Tested _____

[illegible]

AQUIFER TEST DATA (Cont.)

Project _____ Personnel _____ Test Date _____
Well Observed _____ Well Tested _____

[illegible]



HYDROMETRICS INC.

Consulting Scientists and Engineers
Helena, Montana

Recovery Well

Hole Name: HL-99-1

Date Hole Started: 6/17/99 Date Hole Finished: 6/24/99

Client: City of Helena

Project: Groundwater Remediation

County: Lewis and Clark State: Montana

Property Owner: City of Helena

Legal Description: SW,NW,SW Sec19, T10N, R3W

Descriptive Location: South of City of Helena
baseball fields

Recorded By: JR

Drilling Company: H&L Drilling

Driller: Mark Miller

Drilling Method: Air Rotary

Drilling Fluids Used: Water

Purpose of Hole: Install Recovery Well

Target Aquifer: Shallow Groundwater

Hole Diameter (in): 8

Total Depth Drilled (ft): 100

WELL COMPLETION	Y/N	DESCRIPTION	INTERVAL
Well Installed?	Y	8" steel to 40', 5" steel 0-75', screen 73-93', sump 93-98'	
Surface Casing Used?	N		
Screen/Perforations?	Y	0.020 slot stainless steel	73-93
Sand Pack?	Y	10-20 silica sand	70-100'
Annular Seal?	Y	Bentonite Chips	40-70'
Surface Seal?	N		
DEVELOPMENT/SAMPLING			
Well Developed?	Y	pumping at 40 gpm for 3 hours	
Water Samples Taken?	Y	volatile organics	
Boring Samples Taken?	N		

Static Water Level Below MP: 56.70

Surface Casing Height (ft): 1.87

Date: 6/28/99

Riser Height (ft): 1.57

MP Description: top of steel casing

Ground Surface Elevation (ft): 3941.58

MP Height Above or Below Ground (ft): 1.57

MP Elevation (ft): 3943.15

Remarks: N 506507.136 E 506741.293

Northing and Easting are based on City of Helena coordinate positions which are based on Mount Helena having coordinates N500000, E500000

WELL CONSTRUCTION

0.0 8-inch steel casing to
41 feet, 5-inch steel
casing to 100 feet

73.0 0.020 Slot Screen

93.0 5-inch steel casing for
sump

68.0
70.0
J-Packer
10/20 Silica Sand

Bottom of Hole 100.0

GRAPHICS

GEOLOGICAL DESCRIPTION

0.0 - 18.0' Gravel Fill

Sand and Gravel, grey, fine to coarse sand, fine to medium gravel, unconsolidated, dry.

18.0 - 25.0' Gravelly Sand

black, green, red, medium to coarse grain, 1/4 to 1/2 inch size gravel, start adding water for drilling.

25.0 - 30.0' Clayey Gravelly Sand

medium coarse sand as above, fine subrounded gravel, 20% brownish tan clay.

30.0 - 35.0' Clayey Sandy Gravel

dark black, fine to medium size (1/2 to 1.0 -inch) gravel, abundant coarse sand, predominantly diorite composition.

35.0 - 50.0' Gravelly Sand

multicolored, green, black, dark red, coarse grain, angular, trace clayey, abundant argillite, limestone, chert and dark igneous fragments, borehole not making any water.

50.0 - 55.0' Sand

black, dark green, coarse grain, angular, predominantly diorite (?) composition, iron stained, borehole not yielding water.

55.0 - 62.0' Gravelly Sand

sand as above, 5% fine gravel, 15% light tan igneous tuff, borehole making less than 1 gpm.

62.0 - 100.0' Volcanic Tuff

light tan, siliceous, numerous angular rock inclusions, borehole making 5 gpm at 70 feet, 10 gpm at 80 feet, and 12 gpm at 100 feet.



Well Construction Diagram

Geological Description

0.0 8-inch steel casing to
41 feet, 5-inch steel
casing to 100 feet



73.0
0.020 Slot Screen

93.0
5-inch steel casing for
sump

68.0
70.0
J-Packer
10/20 Silica Sand

Bottom of Hole 100.0

0.0 - 18.0'

Gravel Fill

Sand and Gravel, grey, fine to coarse sand, fine to medium gravel, unconsolidated, dry.

18.0 - 25.0'

Gravelly Sand

black, green, red, medium to coarse grain, 1/4 to 1/2 inch size gravel, start adding water for drilling.

25.0 - 30.0'

Clayey Gravelly Sand

medium coarse sand as above, fine subrounded gravel, 20% brownish tan clay.

30.0 - 35.0'

Clayey Sandy Gravel

dark black, fine to medium size (1/2 to 1.0 -inch) gravel, abundant coarse sand, predominantly diorite composition.

35.0 - 50.0'

Gravelly Sand

multicolored, green, black, dark red, coarse grain, angular, trace clayey, abundant argillite, limestone, chert and dark igneous fragments, borehole not making any water.

50.0 - 55.0'

Sand

black, dark green, coarse grain, angular, predominantly diorite (?) composition, iron stained, borehole not yielding water.

55.0 - 62.0'

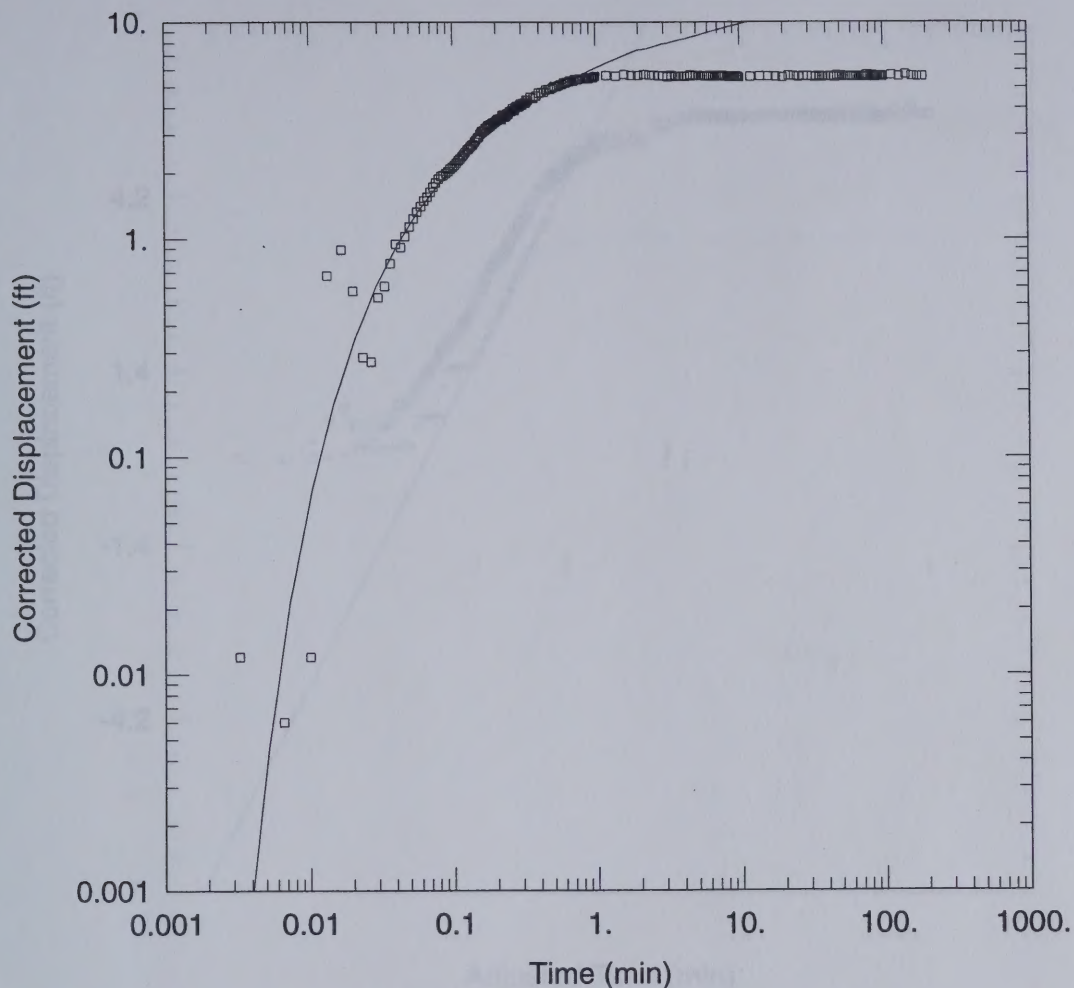
Gravelly Sand

sand as above, 5% fine gravel, 15% light tan igneous tuff, borehole making less than 1 gpm.

62.0 - 100.0'

Volcanic Tuff

light tan, siliceous, numerous angular rock inclusions, borehole making 5 gpm at 70 feet, 10 gpm at 80 feet, and 12 gpm at 100 feet.



HL-99-1 AQUIFER TEST

Data Set: K:\DATA\PROJECT\0054\AQTEST\HL991PMP.AQT

Date: 07/19/99

Time: 12:02:23

PROJECT INFORMATION

Company: Hydrometrics, Inc.

Client: City of Helena

Project: 027/0054

Test Location: North of Landfill

Test Well: HL-99-1

Test Date: 7/12/99

AQUIFER DATA

Saturated Thickness: 40. ft

Anisotropy Ratio (K_z/K_r): 0.1

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
HL-99-1	0	0

Observation Wells

Well Name	X (ft)	Y (ft)
□ HL-99-1	0.21	0

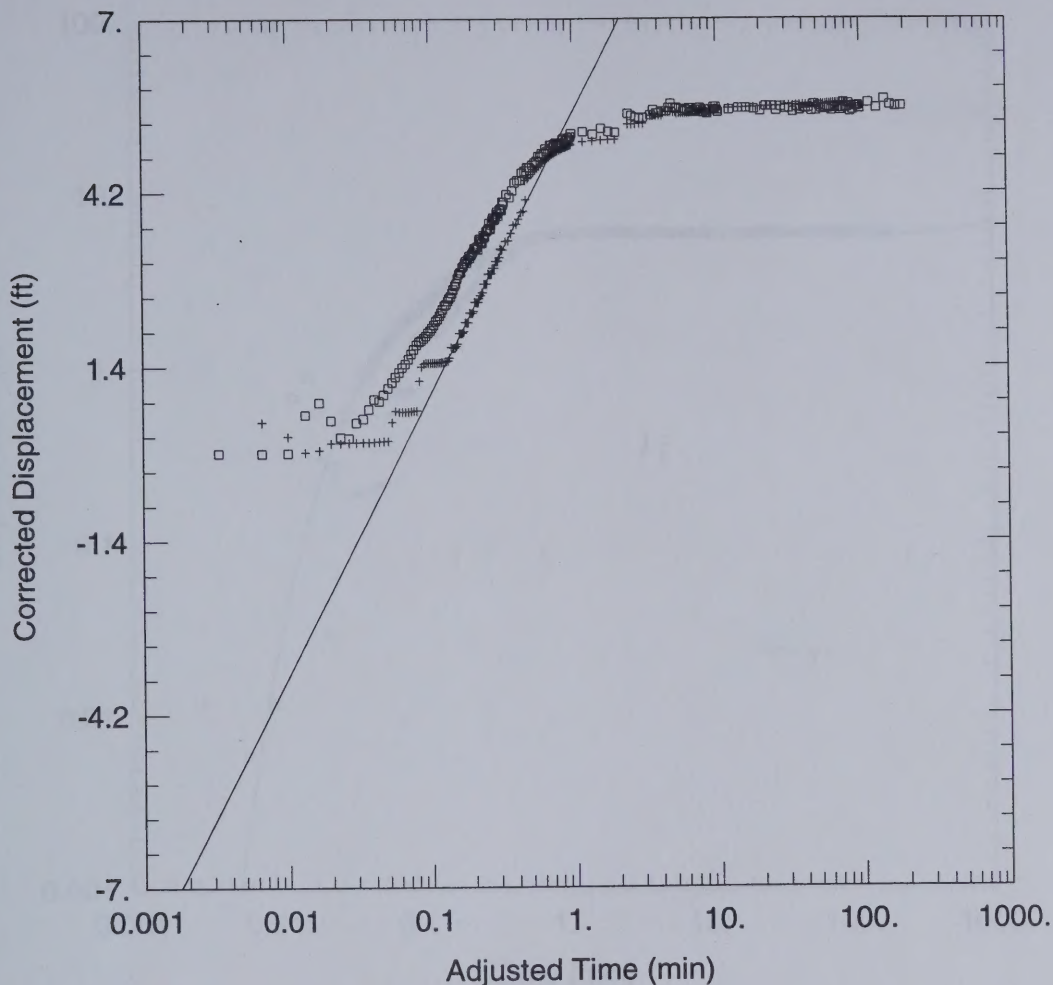
SOLUTION

Aquifer Model: Unconfined

Solution Method: Theis

$T = 196.2 \text{ ft}^2/\text{day}$

$S = 0.2805$



HL-99-1 AQUIFER TEST

Data Set: K:\DATA\PROJECT\0054\AQTEST\HL991P&R.AQT

Date: 07/19/99

Time: 12:09:49

PROJECT INFORMATION

Company: Hydrometrics, Inc.

Client: City of Helena

Project: 027/0054

Test Location: North of Landfill

Test Well: HL-99-1

Test Date: 7/12/99

AQUIFER DATA

Saturated Thickness: 40. ft

Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
HL-99-1	0	0

Observation Wells

Well Name	X (ft)	Y (ft)
□ HL-99-1 Pump	0.21	0
+ HL-99-1 Rec	0.21	0

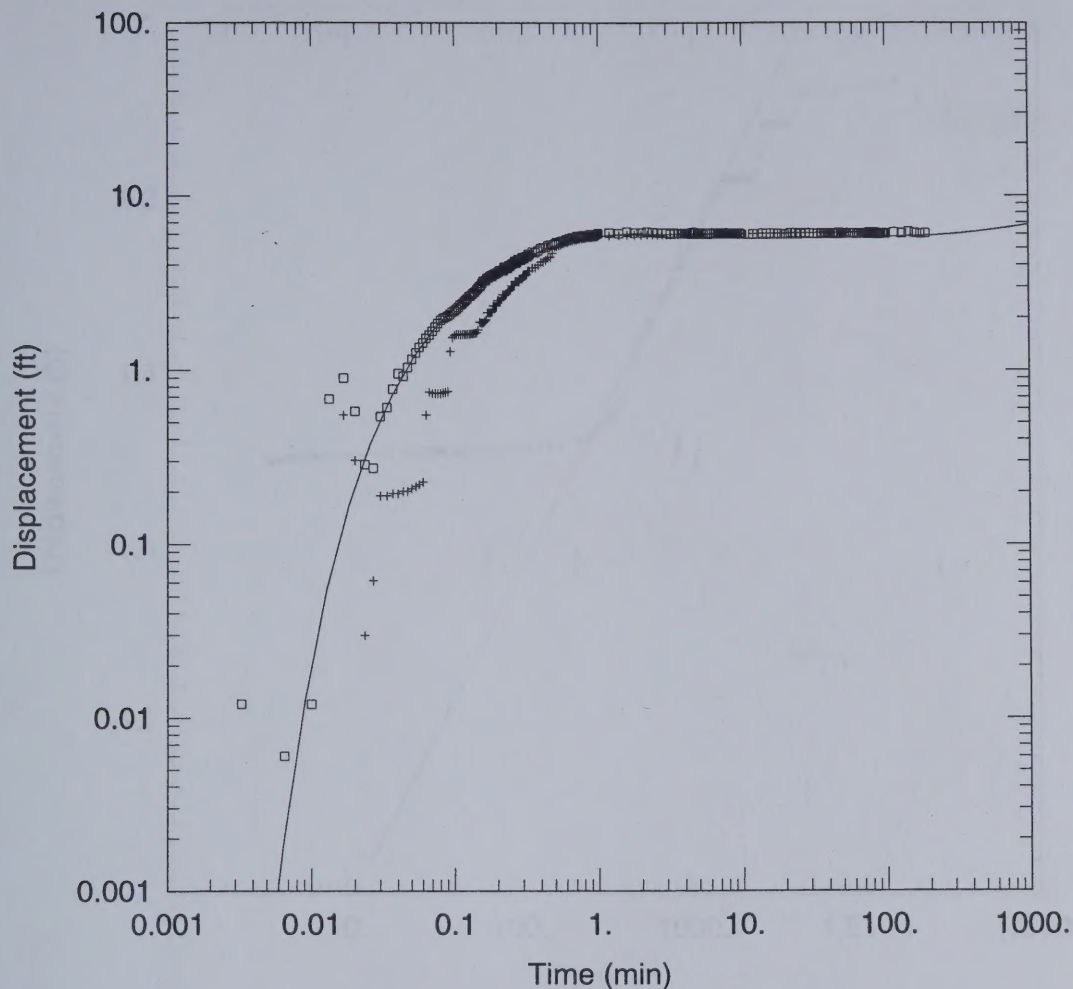
SOLUTION

Aquifer Model: Unconfined

Solution Method: Cooper-Jacob

T = 173.7 ft²/day

S = 0.3787



HL-99-1 AQUIFER TEST

Data Set: K:\DATA\PROJECT\0054\AQTEST\HL991P&R.AQT

Date: 07/23/99

Time: 09:39:00

PROJECT INFORMATION

Company: Hydrometrics, Inc.

Client: City of Helena

Project: 027/0054

Test Location: North of Landfill

Test Well: HL-99-1

Test Date: 7/12/99

AQUIFER DATA

Saturated Thickness: 40. ft

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
HL-99-1	0	0

Observation Wells

Well Name	X (ft)	Y (ft)
□ HL-99-1 Pump	0.21	0
+ HL-99-1 Rec	0.21	0

SOLUTION

Aquifer Model: Unconfined

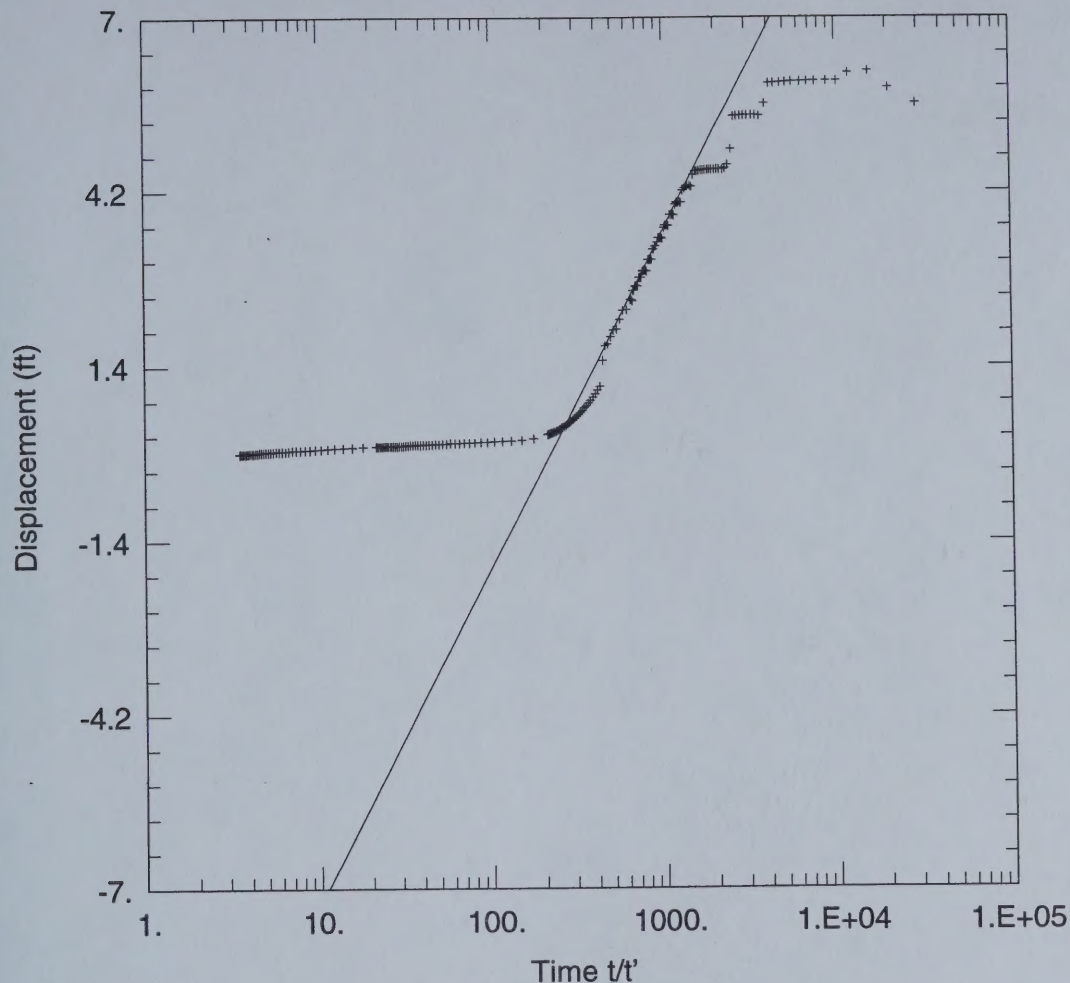
Solution Method: Neuman

T = 154. ft²/day

S = 0.3651

Sy = 640.5

K_r/K_r = 3628.1



HL-99-1 AQUIFER TEST

Data Set: K:\DATA\PROJECT\0054\AQTEST\HL991P&R.AQT

Date: 07/19/99

Time: 12:31:48

PROJECT INFORMATION

Company: Hydrometrics, Inc.

Client: City of Helena

Project: 027/0054

Test Location: North of Landfill

Test Well: HL-99-1

Test Date: 7/12/99

AQUIFER DATA

Saturated Thickness: 40. ft

Anisotropy Ratio (K_z/K_r): 0.1

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
HL-99-1	0	0

Observation Wells

Well Name	X (ft)	Y (ft)
□ HL-99-1 Pump	0.21	0
+ HL-99-1 Rec	0.21	0

SOLUTION

Aquifer Model: Confined

Solution Method: Theis (Recovery)

$T = 145.7 \text{ ft}^2/\text{day}$

$S' = \underline{217.2}$

STANDARD OPERATING PROCEDURE FORM

AQUIFER TEST DATA FORM®

HF-FORM-400

Project Helena Landfill 0054 Personnel J. Bingham, D. Sitch, B. Thompson
 Well Observed HL-99-2 Well Tested HL-99-2 Test Date 7-8-99 W. Crane

Well Description

State MT County L&C Location: T R Sec. Tract
 Borehole Dia. (in) 6" Well Dia. (in) 6" Well Depth (ft) 118'
 Perforated Zone(s) (ft) 93-113 Desc. of MP TBC Stick-up (ft) 164'
 SWL below MP (ft) 58.39' SWL below GS (ft) 56.75'
 Aquifer Name Aquifer Description

Test Description

Test Type: (1) 1 Pumping Well Drawdown 3. Observation Well Drawdown 5. Slug Injection 7. Other
 (circle one) 2. Pumping Well Recovery 4. Observation Well Recovery 6. Bailer Recovery

Distance of Observation Well from Pumping Well (ft) same Pump hp. & type
 Pump Depth (ft) 91' Water Quality Sample Taken? yes no
 Specific Conductance (umhos/cm @25 C) 940 Temp (C) 54.6 Avg. Discharge (gpm) 29
 Test Duration (min) 262 Max WL Change (ft) 18.52' Transmissivity (gpd/ft)
 Storativity Hydraulic Conductivity (gpd/ft)
 Specific Capacity (gpm/ft of drawdown) REMARKS

Date	Time	Drawdown	SWL	Cond	Temp	Q
	10 ¹⁶	0	58.39			27 gpm
	10 ^{21:00}		68.02			
	10 ²²⁻		68.18			
	10 ²⁴		-	960	54.4	
	10 ²⁸⁻		68.02			20 gpm
	10 ^{28:20}	adjusted flow				32 gpm
	10 ³⁸⁻		74.65	834	54.4	29 gpm
	10 ⁴⁶⁻		75.75	786	56.3	28 gpm
	11 ⁰⁵		75.95	907	54.5	30 gpm
	11 ²²		76.09			
	11 ³²		76.25	733	63.70	29 gpm
	12 ¹⁰		76.41			
	12 ²⁰		76.42	861	60.00	29 gpm
	12 ⁵⁰		76.52	869	56.80	30 gpm
	13 ²⁰		76.51	906	55.0	30 gpm
	13 ⁵²		76.65	910	54.5	28 gpm
	14 ¹⁴		76.77	899	55.1	29 gpm
	14 ²²		76.91			

14^{25:30} Shut pump off & Started Recovery Test

14^{26:30}

14^{26:53}

63.30

14^{27:38}

62.00

14^{30:15}

60.00 61.10

14^{33:40}

60.60

1

14^{44:00}

59.80

15⁰⁶⁻

59.14

15²³ 58.93'
 15⁴⁷ 58.75' 1.4'

1612 - stopped data
 logger pulled
 pump

Project 0054 Personnel D. S. L. L. Test Date 7/8/55
Well Observed HL-90-2 Well Tested HL-99-2

[illegible]

AQUIFER TEST DATA (Cont.)

Project 0054 Personnel D.S. 1 & 2 Test Date 7/8/99
Well Observed HL-99-3 Well Tested HL-99-2

[illegible]

AQUIFER TEST DATA (Cont.)

Project 0054

Personnel *D. Site h*

Test Date 7/8/99

Well Observed H4-99-1

Well Tested HL-99-2

[illegible]

AQUIFER TEST DATA (Cont.)

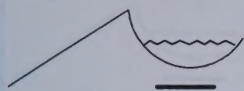
Project 0054 Personnel D. S. L. H Test Date 7/18/99
Well Observed HL-90-3 Well Tested HL-99-2

[illegible]

AQUIFER TEST DATA (Cont.)

Project 0054 Personnel D.S. & L Test Date 7/8/99
Well Observed HL-90-1 Well Tested HL-99-2

[illegible]



HYDROMETRICS INC.

Consulting Scientists and Engineers
Helena, Montana

Recovery Well

Hole Name: HL-99-2

Date Hole Started: 6/16/99 Date Hole Finished: 6/16/99

Client: City of Helena

Project: Groundwater Remediation

County: Lewis and Clark State: Montana

Property Owner: City of Helena

Legal Description: SE,NW,SW Sec19, T10N, R3W

Descriptive Location: South of Golf Course

Driving Range

Recorded By: JR

Drilling Company: H&L Drilling

Driller: Mark Miller

Drilling Method: Air Rotary

Drilling Fluids Used: Water

Purpose of Hole: Install Recovery Well

Target Aquifer: Shallow Groundwater

Hole Diameter (in): 6

Total Depth Drilled (ft): 120

WELL COMPLETION	Y/N	DESCRIPTION	INTERVAL
-----------------	-----	-------------	----------

Well Installed?	Y	6" steel to 95', screen 93 to 113', sump 113-118'	
-----------------	---	---	--

Surface Casing Used?	N		
----------------------	---	--	--

Screen/Perforations?	Y	0.020 slot stainless steel	93-113
----------------------	---	----------------------------	--------

Sand Pack?	N		
------------	---	--	--

Annular Seal?	Y	Bentonite powder behind driven steel 0-95'	
---------------	---	--	--

Surface Seal?	N		
---------------	---	--	--

DEVELOPMENT/SAMPLING

Well Developed?	Y	pumping at 30 gpm for 4 hours	
-----------------	---	-------------------------------	--

Water Samples Taken?	Y	volatile organics	
----------------------	---	-------------------	--

Boring Samples Taken?	N		
-----------------------	---	--	--

Static Water Level Below MP: 57.75

Date: 6/28/99

MP Description: top of steel casing

MP Height Above or Below Ground (ft): 1.64

Surface Casing Height (ft): 1.64

Riser Height (ft): 1.64

Ground Surface Elevation (ft): 3944.11

MP Elevation (ft): 3945.75

Remarks: N 506349.567 E 507807.083

Northing and Easting are based on City of Helena coordinate positions which are based on Mount Helena having coordinates N500000, E500000

WELL CONSTRUCTION

0.0 Bentonite Grout

93.0

0.020 Slot Screen

J-Packer

91.0

Bottom of Hole

120.0

GRAPHICS

GEOLOGICAL DESCRIPTION

0.0 - 5.0' Gravelly Sand

tan, light brown, fine to coarse grain, moderately rounded, poorly sorted, dry, 10% 1-inch gravel, unconsolidated.

5.0 - 15.0' Gravelly Sand

as above, primarily fine grain sand, moderately sorted, dry, unconsolidated.

15.0 - 18.0' Sand

as above, light brown, becoming clayey and slightly moist at 18 feet.

18.0 - 35.0' Clayey Sand

brown, black, white, coarse grain, moderately sorted, clayey, start adding water for drilling, trace fine gravel.

35.0 - 40.0' Gravelly Sand

brown, black, coarse grain, angular, moderately sorted, hard drilling, still dry, water levels in area wells are at 55 feet below ground surface.

40.0 - 45.0' Clayey Sand

multicolored, coarse grain, well sorted, clayey, hard drilling, borehole not yielding any water.

45.0 - 50.0' Gravelly Sand

as above, coarse grain, no clay, hard drilling, dry, gravel is 1-inch in size, moderately rounded.

50.0 - 60.0' Gravelly Clayey Sand

multicolored, coarse grain, angular, clayey, light brown clay.

60.0 - 75.0' Gravelly Sand

multicolored as above, coarse grain, 15-20% fine gravel, subangular to moderately rounded. Stop at 60 feet and let hole sit for 5 minutes to check for water. Borehole making less than 1/4 gpm.

75.0 - 80.0' Gravelly Clayey Sand

multicolored sand and gravel, coarse grain sand, angular, fine 1-inch size gravel, moderately rounded, clayey, clay is light tan and sticky.

80.0 - 85.0' Gravelly Sand

as above, no clay, borehole not making much water, driller adding approximately 5 gpm for drilling.

85.0 - 90.0' Sand

multicolored, red, green, black, coarse grain, trace fine gravel.

90.0 - 95.0' Clayey Gravelly Sand

multicolored as above, coarse grain, clayey, 10% fine 1-inch subrounded gravel.

95.0 - 105.0' Gravelly Sand

as above, coarse grain, angular, moderately sorted, dense but not cemented, borehole making approximately 6 gpm.

105.0 - 120.0' Gravelly Sand

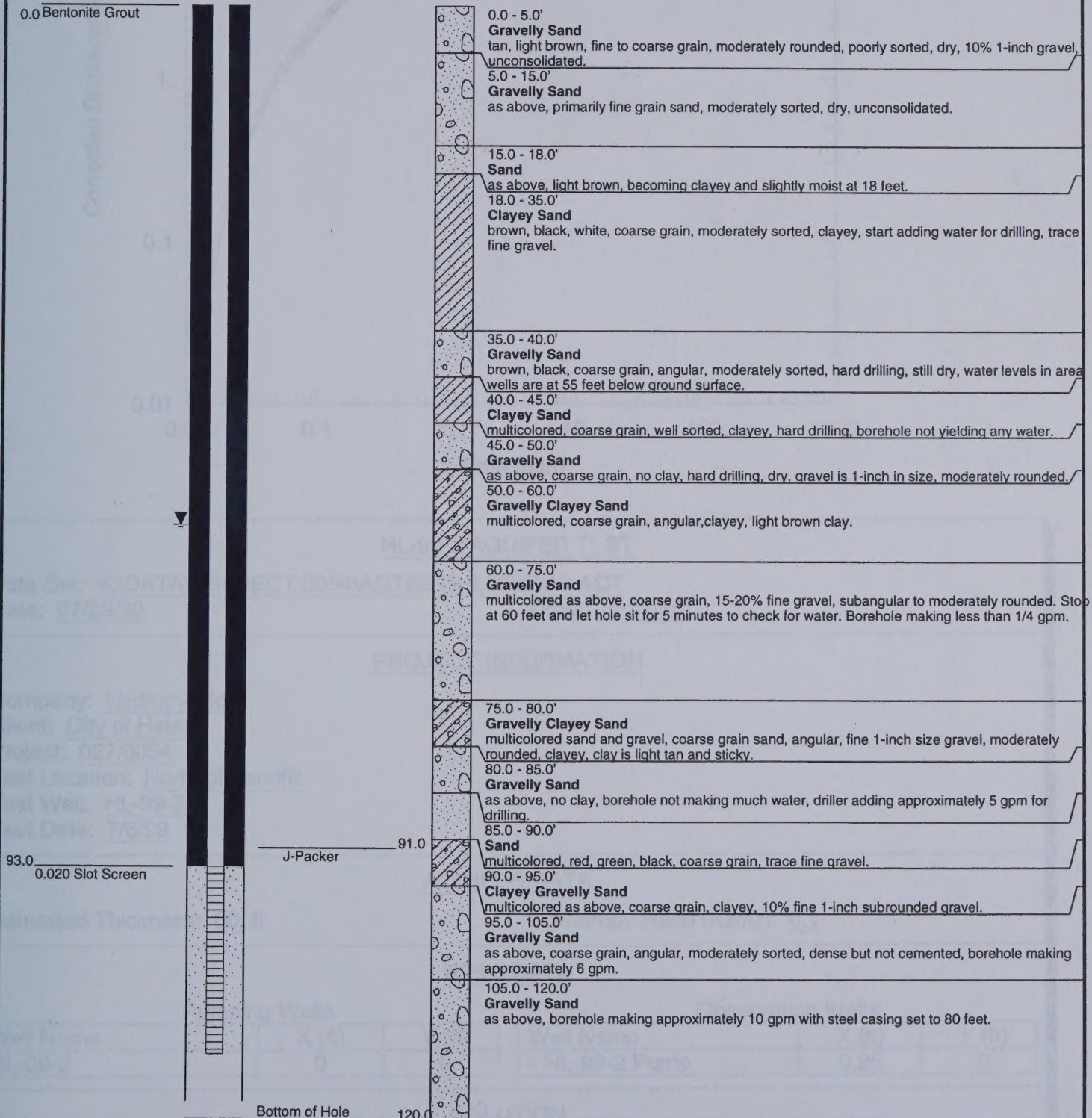
as above, borehole making approximately 10 gpm with steel casing set to 80 feet.

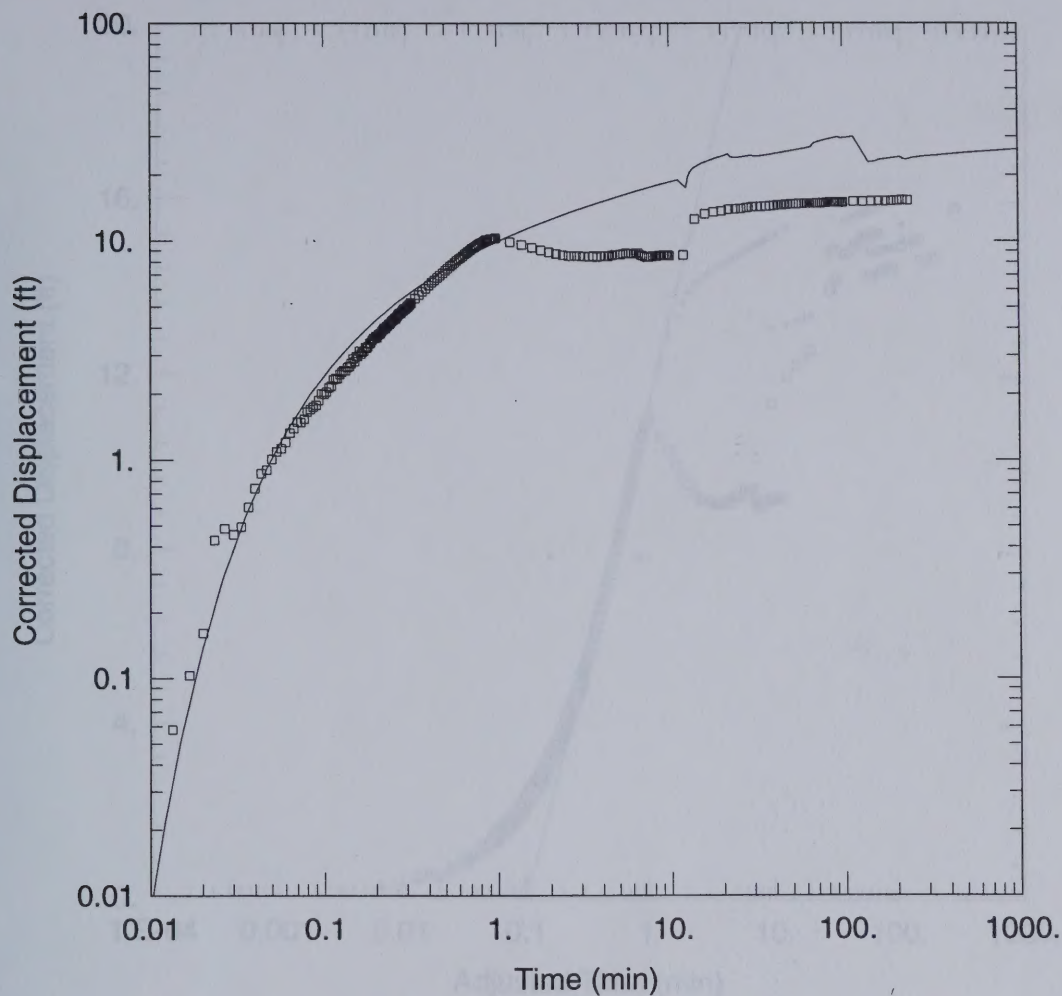


Well Construction Diagram

Geological Description

0.0 Bentonite Grout





HL-99-2 AQUIFER TEST

Data Set: K:\DATA\PROJECT\0054\AQTEST\HL992PMP.AQT

Date: 07/23/99

Time: 10:31:30

PROJECT INFORMATION

Company: Hydrometrics

Client: City of Helena

Project: 027/0054

Test Location: North of Landfill

Test Well: HL-99-2

Test Date: 7/8/99

AQUIFER DATA

Saturated Thickness: 60. ft

Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
HL-99-2	0	0

Observation Wells

Well Name	X (ft)	Y (ft)
□ HL-99-2 Pump	0.25	0

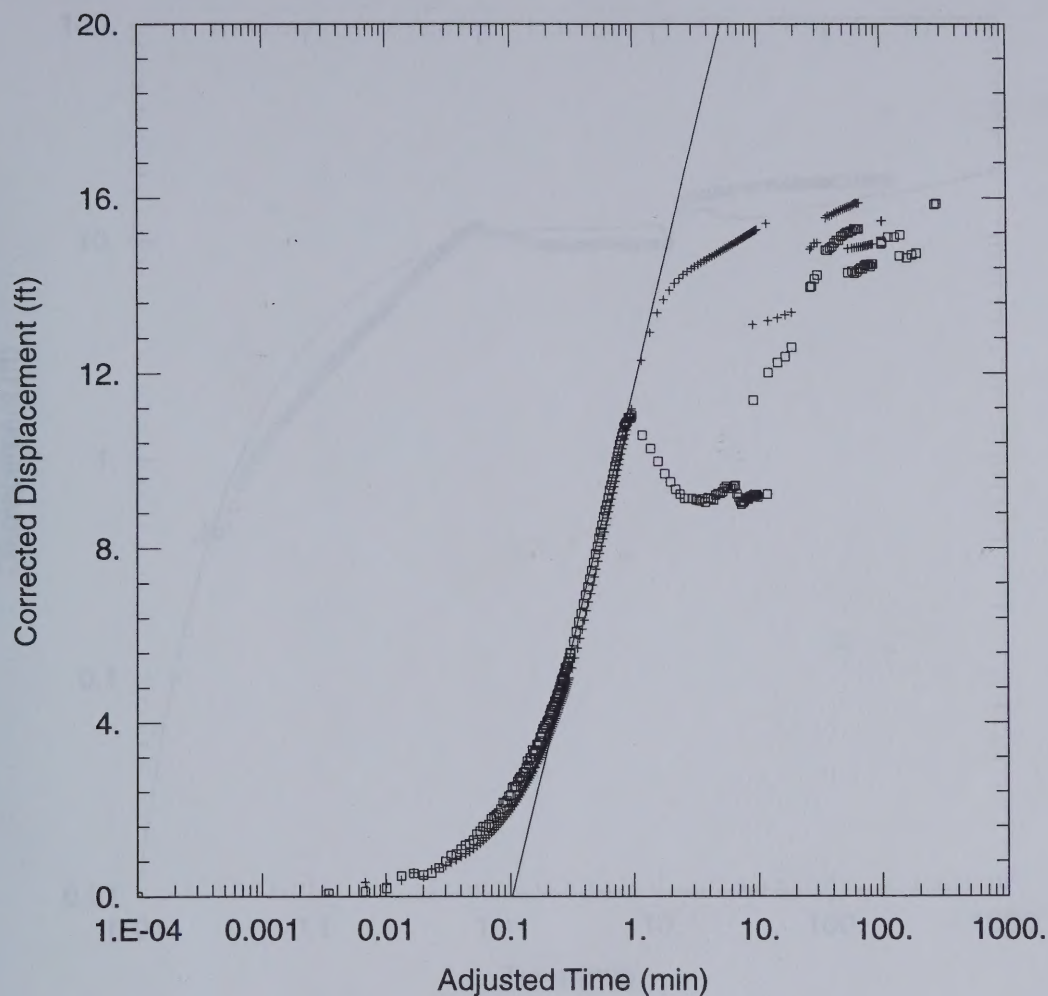
SOLUTION

Aquifer Model: Unconfined

Solution Method: Theis

T = 107.9 ft²/day

S = 0.214



HL-99-2 AQUIFER TEST

Data Set: K:\DATA\PROJECT\0054\AQTEST\HL992P&R.AQT

Date: 07/15/99

Time: 11:07:16

PROJECT INFORMATION

Company: Hydrometrics

Client: City of Helena

Project: 027/0054

Test Location: North of Landfill

Test Well: HL-99-2

Test Date: 7/8/99

AQUIFER DATA

Saturated Thickness: 60. ft

Anisotropy Ratio (K_z/K_r): 0.1

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
HL-99-2	0	0

Observation Wells

Well Name	X (ft)	Y (ft)
□ HL-99-2 Pump	0.25	0
+ HL-99-2 Rec	0.25	0

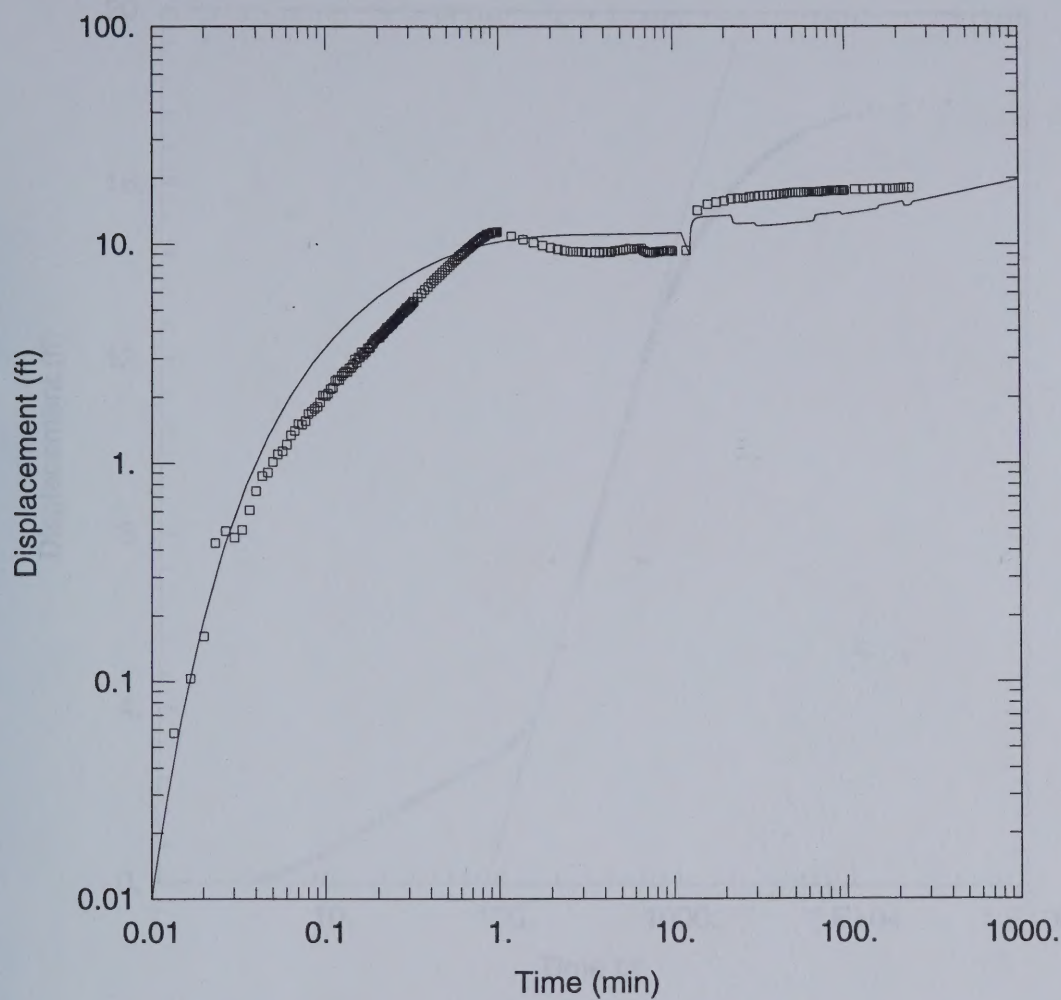
SOLUTION

Aquifer Model: Unconfined

Solution Method: Cooper-Jacob

$T = 86.81 \text{ ft}^2/\text{day}$

$S = 0.224$



HL-99-2 AQUIFER TEST

Data Set: K:\DATA\PROJECT\0054\AQTEST\HL992PMP.AQT

Date: 07/23/99

Time: 10:30:45

PROJECT INFORMATION

Company: Hydrometrics

Client: City of Helena

Project: 027/0054

Test Location: North of Landfill

Test Well: HL-99-2

Test Date: 7/8/99

AQUIFER DATA

Saturated Thickness: 60. ft

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
HL-99-2	0	0

Observation Wells

Well Name	X (ft)	Y (ft)
□ HL-99-2 Pump	0.25	0

SOLUTION

Aquifer Model: Unconfined

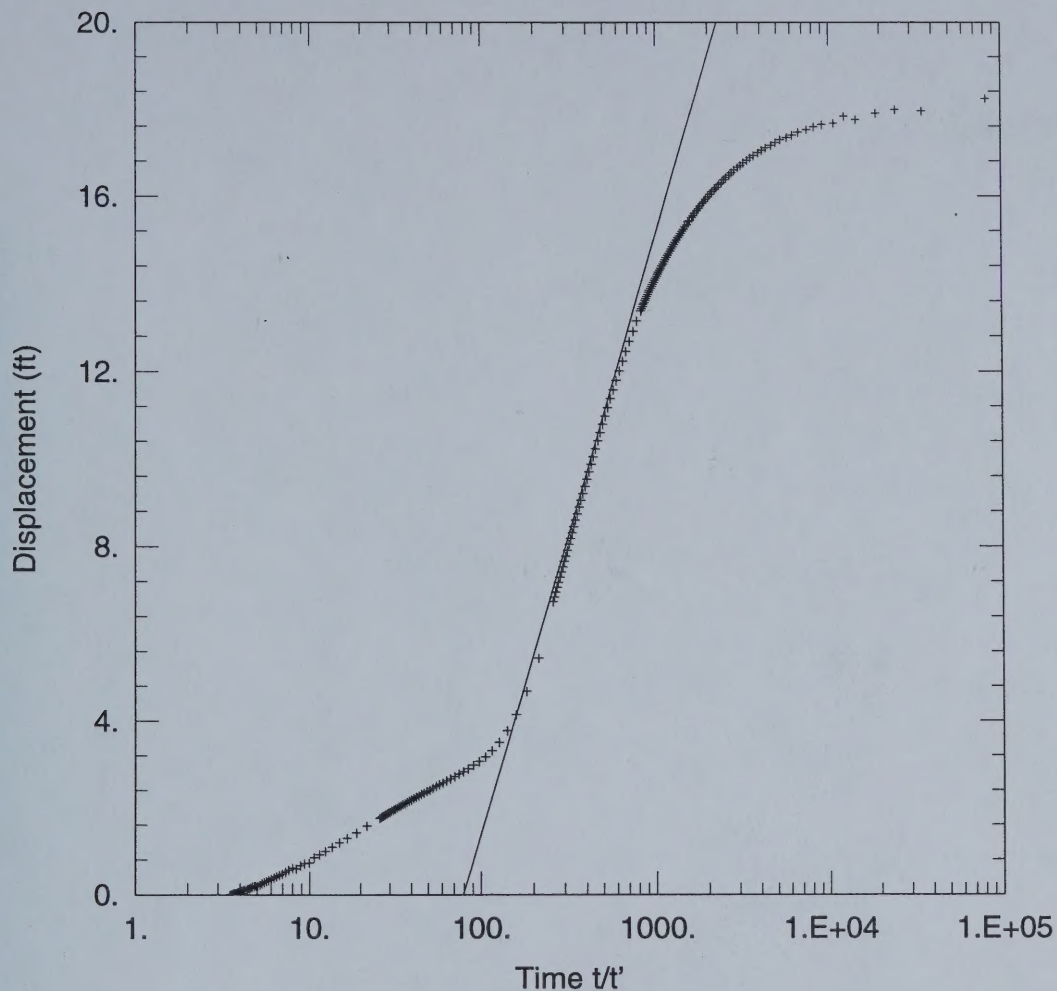
Solution Method: Neuman

$T = 121.7 \text{ ft}^2/\text{day}$

$S = 0.2667$

$S_y = 32.83$

$\beta = 0.1$



HL-99-2 AQUIFER TEST

Data Set: K:\DATA\PROJECT\0054\AQTEST\HL992REC.AQT

Date: 07/15/99

Time: 11:39:14

PROJECT INFORMATION

Company: Hydrometrics

Client: City of Helena

Project: 027/0054

Test Location: North of Landfill

Test Well: HL-99-2

Test Date: 7/8/99

AQUIFER DATA

Saturated Thickness: 60. ft

Anisotropy Ratio (K_z/K_r): 0.1

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
HL-99-2	0	0

Observation Wells

Well Name	X (ft)	Y (ft)
□ HL-99-2 Pump	0.25	0
+ HL-99-2 Rec	0.25	0

SOLUTION

Aquifer Model: Confined

Solution Method: Theis (Recovery)

$T = 74.41 \text{ ft}^2/\text{day}$

$S' = 79.43$

STANDARD OPERATING PROCEDURE FORM

AQUIFER TEST DATA FORM[®]

HF-FORM-400

Project Helena Landfill Personnel D. Sitch, J. Bingham, B. Thompson
 Well Observed HL-99-3 Well Tested HL 99-3 Test Date 7-9-99

Well Description

State MT County Lea Location: T R Sec. Tract
 Borehole Dia. (in) 8" Well Dia. (in) 8" to 20.5" to 105" Well Depth (ft) 105
 Perforated Zone(s) (ft) 80-100' Desc. of MP top of casing Stick-up (ft) 1.52'
 SWL below MP (ft) 54.04' SWL below GS (ft) 52.52'
 Aquifer Name Aquifer Description

Test Description

Test Type: (1) Pumping Well Drawdown 3. Observation Well Drawdown 5. Slug Injection 7. Other
 (circle one) 2. Pumping Well Recovery 4. Observation Well Recovery 6. Bailer Recovery

Distance of Observation Well from Pumping Well (ft) 0.333' Pump hp. & type 2HP Arrowwater (?)
 Pump Depth (ft) 76.5' Water Quality Sample Taken? yes ☒ no ☐
 Specific Conductance (umhos/cm @25 C) 982 Temp (C) 54.7 Avg. Discharge (gpm) 28
 Test Duration (min) 180 Max WL Change (ft) 8.17' Transmissivity (gpd/ft)
 Storativity Hydraulic Conductivity (gpd/ft)
 Specific Capacity (gpm/ft of drawdown) REMARKS

Date	Time	SWL	SC	T			Q
7-9-99	8:06	53.97					
	8:12	54.04	used different solinst #21 - will use for remainder				
	8:52	54.03	- started test - adjusting flow to 27.5 gpm				
	9:03	59 -	stopped pump & let receiver				
	9:32	54.15	- started pump again				
	9:34.5	60.10	917	54.7			28 gpm
	9:37	60.55					
	9:40	61.02	982	52.7			28 gpm
	9:45	61.44	990	55.5			27.9 gpm
	9:50	61.60					28.0
	9:55	61.78	889	57.3			28.2
	10:17	62.08	850	60.3			28.0
	1046	62.21	865	60.5			28.0
	1120	62.25	866	59.9			28.0
	1237	62.32	841	60.5	- sample to		28.0
	12:40:20	stopped pump & started recovery test					0

12:40:36 60.0
 60.5
 12:40:50 59.0
 12:41:10 58.0
 12:41:51 57.0
 12:44:07 56.0
 12:46:51 56.5
 12:53:14 55.0

1304:41 54.50'
 1325 54.30'
 1337 54.20'
 1353 54.15'

AQUIFER TEST DATA (Cont.)

Project 0054 Personnel H.S. J. L. Test Date 7/9/84
Well Observed HL-90-2 Well Tested HL-99-3

Date	Time	SWL
7/9/99	0846	51.31'
	1001	51.31
	1108	51.34'
	1221	51.36'
1318	1349	51.36'
	1351	51.36'

AQUIFER TEST DATA (Cont.)

Project 0054 Personnel D. S. & L. Test Date 7/5/99
Well Observed HL-99-3 Well Tested HL-99-3

[illegible]

AQUIFER TEST DATA (Cont.)

Project 00541 Personnel D. S. F. L. Test Date 7/5/99
Well Observed HL-99-1 Well Tested HL-99-3

[illegible]

AQUIFER TEST DATA (Cont.)

Project 0054 Personnel D.S. del Test Date 7/9/89
Well Observed HL-90-3 Well Tested HL-99-3

[illegible]

AQUIFER TEST DATA (Cont.)

Project 0054 Personnel D. S. L. C. H. Test Date 7/9/99
Well Observed 44-90-1 Well Tested 44-99-3

[illegible]



HYDROMETRICS INC.

Consulting Scientists and Engineers
Helena, Montana

Recovery Well

Hole Name: HL-99-3

Date Hole Started: 6/17/99 Date Hole Finished: 6/23/99

Client: City of Helena

Project: Groundwater Remediation

County: Lewis and Clark State: Montana

Property Owner: City of Helena

Legal Description: SE,NW,SW Sec19, T10N, R3W

Descriptive Location: South of Bill Roberts
Golf Course

Recorded By: JR

Drilling Company: H&L Drilling

Driller: Mark Miller

Drilling Method: Air Rotary

Drilling Fluids Used: Water

Purpose of Hole: Install Recovery Well

Target Aquifer: Shallow Groundwater

Hole Diameter (in): 8

Total Depth Drilled (ft): 100

WELL COMPLETION	Y/N	DESCRIPTION	INTERVAL
Well Installed?	Y	8" steel to 80 feet, 5" screen 80 to 100', sump 100-105'	
Surface Casing Used?	N		
Screen/Perforations?	Y	0.020 slot stainless steel	80-100
Sand Pack?	N		
Annular Seal?	Y	Bentonite powder behind driven steel 0-80'	
Surface Seal?	N		
DEVELOPMENT/SAMPLING			
Well Developed?	Y	pumping at 40 gpm for 3 hours	
Water Samples Taken?	Y	volatile organics	
Boring Samples Taken?	N		

Static Water Level Below MP: 53.15

Date: 6/28/99

MP Description: top of steel casing

MP Height Above or Below Ground (ft): 1.52

Surface Casing Height (ft): 1.52

Riser Height (ft): 1.52

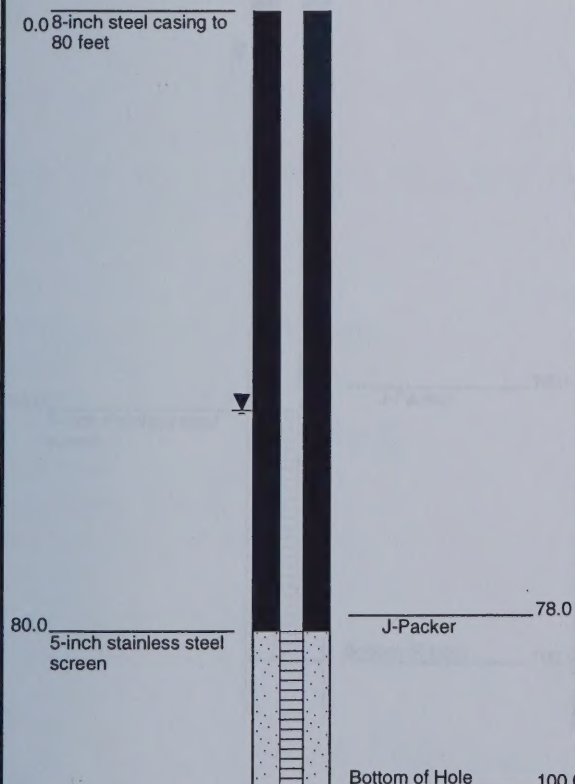
Ground Surface Elevation (ft): 3946.53

MP Elevation (ft): 3948.05

Remarks: N 506109.625 E 507616.831

Northing and Easting are based on City of Helena coordinate positions which are based on Mount Helena having coordinates N500000, E500000

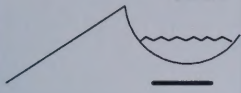
WELL CONSTRUCTION



GRAPHICS

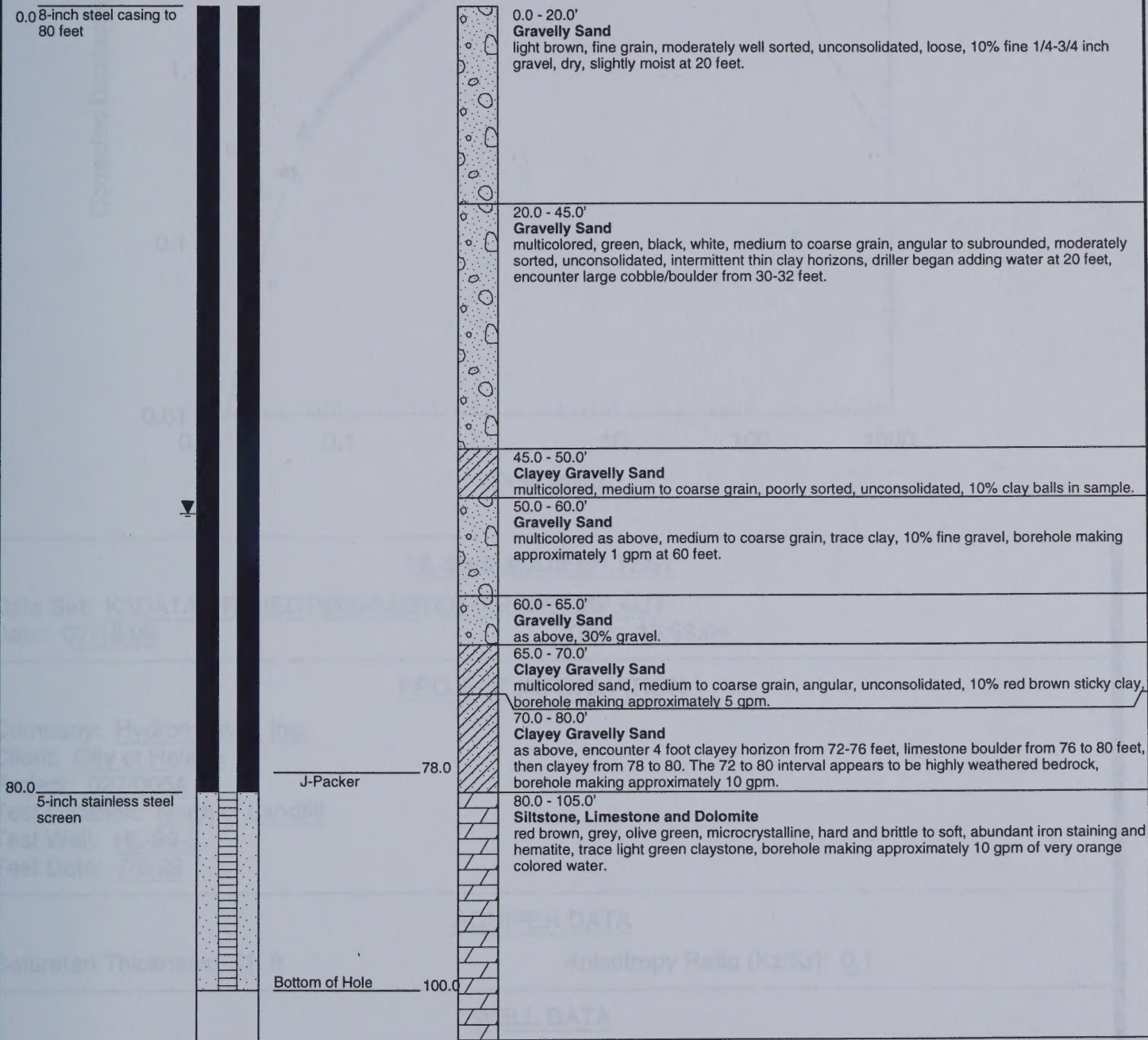
GEOLOGICAL DESCRIPTION

0.0 - 20.0' Gravelly Sand light brown, fine grain, moderately well sorted, unconsolidated, loose, 10% fine 1/4-3/4 inch gravel, dry, slightly moist at 20 feet.
20.0 - 45.0' Gravelly Sand multicolored, green, black, white, medium to coarse grain, angular to subrounded, moderately sorted, unconsolidated, intermittent thin clay horizons, driller began adding water at 20 feet, encounter large cobble/boulder from 30-32 feet.
45.0 - 50.0' Clayey Gravelly Sand multicolored, medium to coarse grain, poorly sorted, unconsolidated, 10% clay balls in sample.
50.0 - 60.0' Gravelly Sand multicolored as above, medium to coarse grain, trace clay, 10% fine gravel, borehole making approximately 1 gpm at 60 feet.
60.0 - 65.0' Gravelly Sand as above, 30% gravel.
65.0 - 70.0' Clayey Gravelly Sand multicolored sand, medium to coarse grain, angular, unconsolidated, 10% red brown sticky clay, borehole making approximately 5 gpm.
70.0 - 80.0' Clayey Gravelly Sand as above, encounter 4 foot clayey horizon from 72-76 feet, limestone boulder from 76 to 80 feet, then clayey from 78 to 80. The 72 to 80 interval appears to be highly weathered bedrock, borehole making approximately 10 gpm.
80.0 - 105.0' Siltstone, Limestone and Dolomite red brown, grey, olive green, microcrystalline, hard and brittle to soft, abundant iron staining and hematite, trace light green claystone, borehole making approximately 10 gpm of very orange colored water.

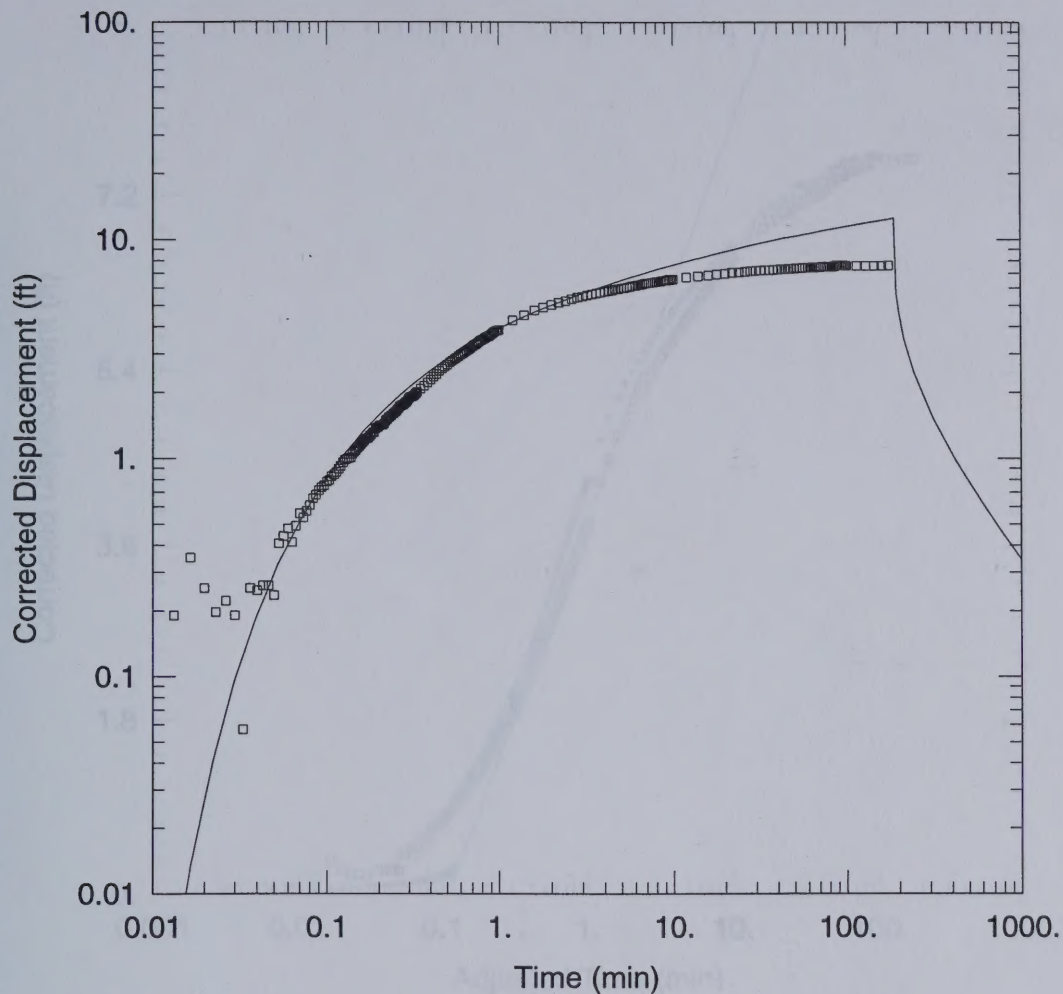


**Well Construction
Diagram**

Geological Description



WELL DIAGRAM 0054.GPJ HYD-TUC.GDT 8/2/99



HL-99-3 AQUIFER TEST

Data Set: K:\DATA\PROJECT\0054\AQTEST\HL993PMP.AQT

Date: 07/16/99

Time: 15:59:04

PROJECT INFORMATION

Company: Hydrometrics, Inc.

Client: City of Helena

Project: 027/0054

Test Location: North of Landfill

Test Well: HL-99-3

Test Date: 7/9/99

AQUIFER DATA

Saturated Thickness: 51. ft

Anisotropy Ratio (K_z/K_r): 0.1

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
HL-99-3	0	0

Observation Wells

Well Name	X (ft)	Y (ft)
□ HL-99-3	0.333	0

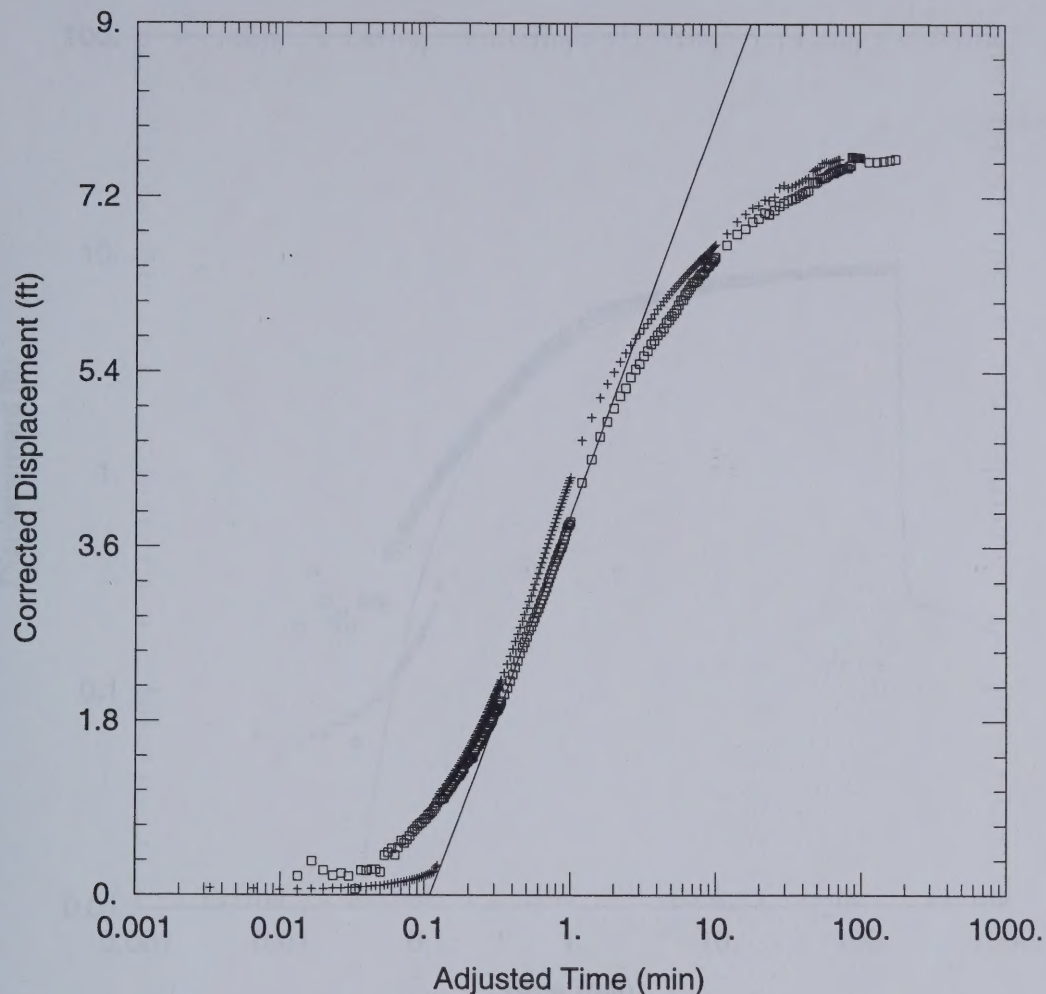
SOLUTION

Aquifer Model: Unconfined

Solution Method: Theis

$T = 258.1 \text{ ft}^2/\text{day}$

$S = 0.3642$



HL-99-3 AQUIFER TEST

Data Set: K:\DATA\PROJECT\0054\AQTEST\HL993P&R.AQT

Date: 07/19/99

Time: 11:18:38

PROJECT INFORMATION

Company: Hydrometrics, Inc.

Client: City of Helena

Project: 027/0054

Test Location: North of Landfill

Test Well: HL-99-3

Test Date: 7/9/99

AQUIFER DATA

Saturated Thickness: 51. ft

Anisotropy Ratio (K_z/K_r): 0.1

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
HL-99-3	0	0

Observation Wells

Well Name	X (ft)	Y (ft)
□ HL-99-3 Pump	0.333	0
+ HL-99-3 Rec	0.333	0

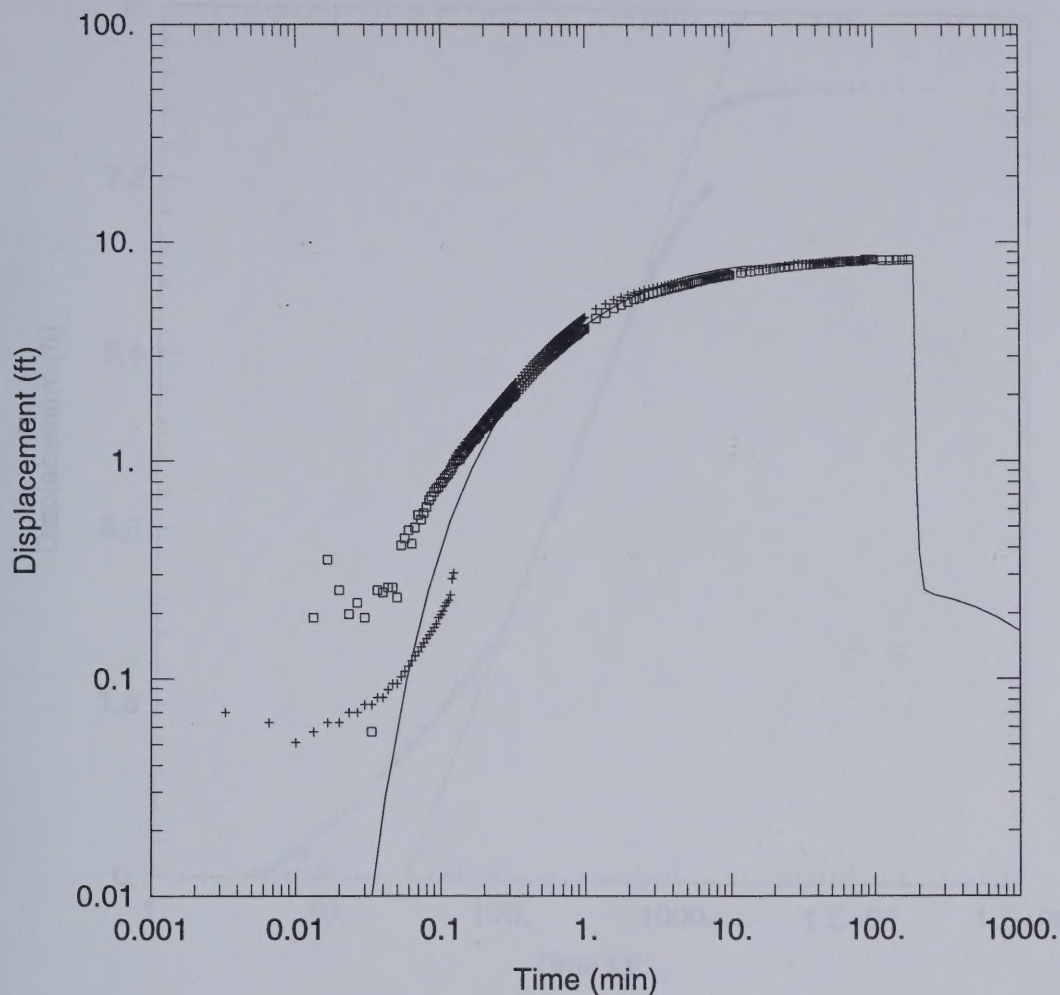
SOLUTION

Aquifer Model: Unconfined

Solution Method: Cooper-Jacob

$T = 242. \text{ ft}^2/\text{day}$

$S = 0.3746$



HL-99-3 AQUIFER TEST

Data Set: K:\DATA\PROJECT\0054\AQTEST\HL993P&R.AQT

Date: 07/19/99

Time: 11:21:34

PROJECT INFORMATION

Company: Hydrometrics, Inc.

Client: City of Helena

Project: 027/0054

Test Location: North of Landfill

Test Well: HL-99-3

Test Date: 7/9/99

AQUIFER DATA

Saturated Thickness: 51. ft

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
HL-99-3	0	0

Observation Wells

Well Name	X (ft)	Y (ft)
□ HL-99-3 Pump	0.333	0
+ HL-99-3 Rec	0.333	0

SOLUTION

Aquifer Model: Unconfined

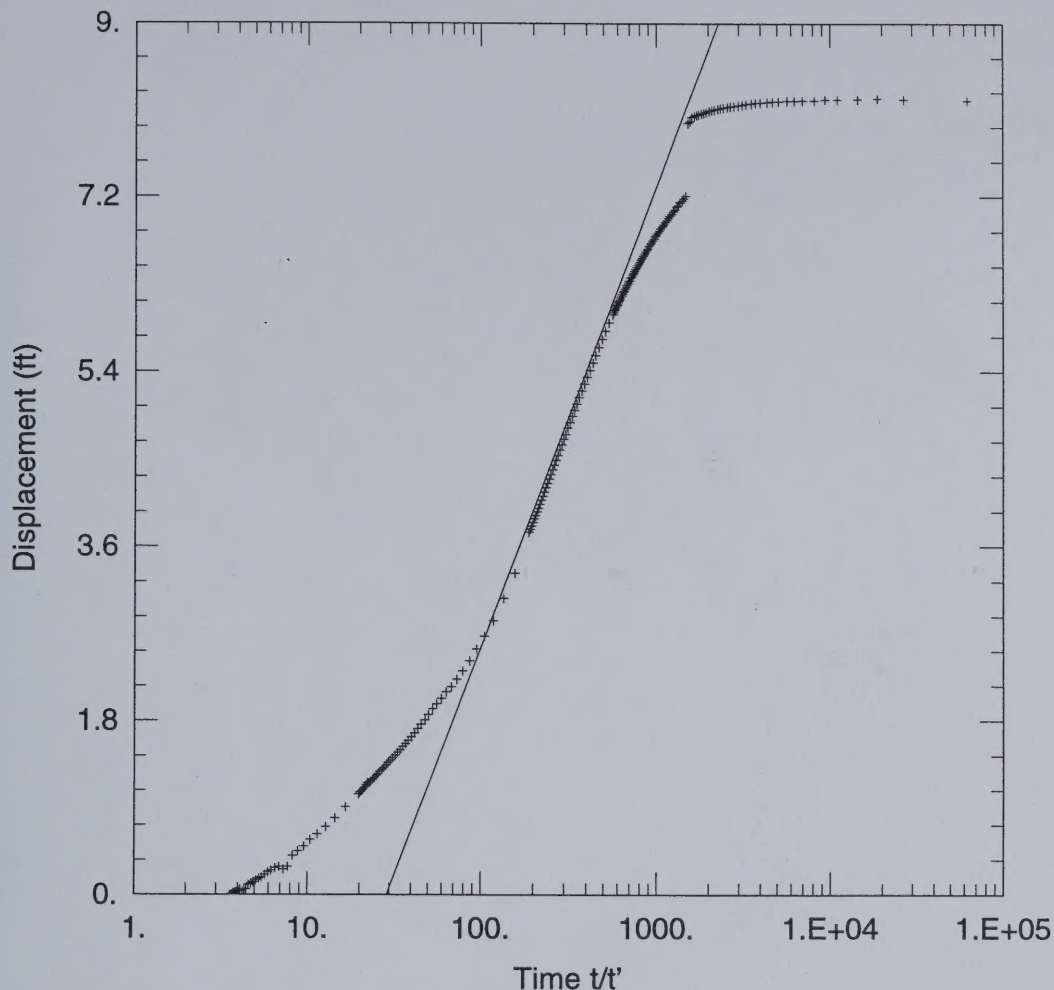
Solution Method: Neuman

T = 263.6 ft²/day

S = 0.9328

Sy = 95.01

Kz/Kx = 702.7



HL-99-3 AQUIFER TEST

Data Set: K:\DATA\PROJECT\0054\AQTEST\HL993P&R.AQT

Date: 07/19/99

Time: 11:32:38

PROJECT INFORMATION

Company: Hydrometrics, Inc.

Client: City of Helena

Project: 027/0054

Test Location: North of Landfill

Test Well: HL-99-3

Test Date: 7/9/99

AQUIFER DATA

Saturated Thickness: 51. ft

Anisotropy Ratio (K_z/K_r): 0.1

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
HL-99-3	0	0

Observation Wells

Well Name	X (ft)	Y (ft)
□ HL-99-3 Pump	0.333	0
+ HL-99-3 Rec	0.333	0

SOLUTION

Aquifer Model: Confined

Solution Method: Theis (Recovery)

$T = 208.2 \text{ ft}^2/\text{day}$

$S' = \underline{29.05}$



Case Narrative

On June 19, 1999, one water sample from a project identified as "0054" was received by our laboratory for analysis. The sample, which included a label, report and cover delivered by Judi Bingham. The label of custody indicated that the collected water is for analysis of 2,3,4,5-Tetrahydro-2H-Pyran-2-one.

Results are documented in the following report.

If you have any questions regarding this analysis, feel free to call us at 1-800-428-2222 or 800-814-6472.

We appreciate the fact that you have chosen us as your analytical lab.

Sincerely yours,

APPENDIX C

WATER QUALITY SAMPLING INFORMATION

Harry H. H. H.
Laboratory Manager



Case Narrative

On June 18, 1999, one water sample from a project identified as "0054" was received by our laboratory for analysis. The samples were received cool, intact and hand delivered by Jodi Bingham. The chain of custody indicated that the samples were to be analyzed by 524.2-Volatile Organic Compounds.

Results are summarized in the following pages.

Should you have any questions regarding this analysis feel free to give us a call at 449-6282 or 800-814-6282.

We appreciate the fact that you have chosen us as your analytical lab.

Sincerely yours,


Harry Howell
Laboratory Manager

Alpine Analytical, Inc.

2814 N. Cooke, Helena, MT 59601

(406)449-6282

Client: Hydrometrics

Project ID: 0054

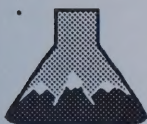
Site ID: Helena Landfill

Date Sampled: 18-Jun-99

Date Received: 18-Jun-99

Chain of Custody #: Hydro

524.2	HL-99-2
Tetrachloroethene, ug/L	4.3



Alpine Analytical, Inc.

2814 N. Cooke, Helena, MT 59601

(406)449-6282

VOLATILE ORGANIC COMPOUNDS

Client: Hydrometrics

Date Reported: 21-Jun-99

Sample ID: HL-99-2

Project ID: 0054

Chain of Custody #: Hydro

Site ID: Helena Landfill

Laboratory ID: 6G281
Sample Matrix: Water
Preservatives: HCl, Cool
Condition: Intact

Date / Time Sampled: 18-Jun-99 @ 15:58
Date / Time Received: 18-Jun-99 @ 16:22
Date / Time Extracted: NA
Date / Time Analyzed: 18-Jun-99 @ 16:30

Parameter	Analytical Result(ug/L)	PQL (ug/L)	Parameter	Analytical Result(ug/L)	PQL (ug/L)
dichlorodifluoromethane	ND	1.0	1,2-dibromoethane	ND	1.0
chloromethane	ND	1.0	chlorobenzene	ND	1.0
vinyl chloride	ND	1.0	1,1,1,2-tetrachloroethane	ND	1.0
bromomethane	ND	1.0	ethylbenzene	ND	1.0
chloroethane	ND	1.0	m, p-xylene	ND	1.0
trichlorofluoromethane	ND	1.0	o-xylene	ND	1.0
1,1-dichloroethene	ND	1.0	styrene	ND	1.0
methylene chloride	ND	1.0	bromoform	ND	1.0
trans-1,2-dichloroethene	ND	1.0	isopropylbenzene	ND	1.0
1,1-dichloroethane	ND	1.0	1,1,2,2-tetrachloroethane	ND	1.0
2,2-dichloropropane	ND	1.0	1,2,3-trichloropropane	ND	1.0
cis-1,2-dichloroethene	ND	1.0	n-propylbenzene	ND	1.0
chloroform	ND	1.0	bromobenzene	ND	1.0
bromochloromethane	ND	1.0	1,3,5-trimethylbenzene	ND	1.0
1,1,1-trichloroethane	ND	1.0	2-chlorotoluene	ND	1.0
1,1-dichloropropene	ND	1.0	4-chlorotoluene	ND	1.0
carbon tetrachloride	ND	1.0	tert-butylbenzene	ND	1.0
1,2-dichloroethane	ND	1.0	1,2,4-trimethylbenzene	ND	1.0
benzene	ND	1.0	sec-butylbenzene	ND	1.0
trichloroethene	ND	1.0	isopropyltoluene	ND	1.0
1,2-dichloropropane	ND	1.0	1,3-dichlorobenzene	ND	1.0
bromodichloromethane	ND	1.0	1,4-dichlorobenzene	ND	1.0
dibromomethane	ND	1.0	butylbenzene	ND	1.0
cis-1,3-dichloropropene	ND	1.0	1,2-dichlorobenzene	ND	1.0
toluene	ND	1.0	1,2-dibromo-3-chloropropane	ND	1.0
trans-1,3-dichloropropene	ND	1.0	1,2,4-trichlorobenzene	ND	1.0
1,1,2-trichloroethane	ND	1.0	hexachlorobutadiene	ND	1.0
1,3-dichloropropane	ND	1.0	naphthalene	ND	1.0
tetrachloroethene	4.3	1.0	1,2,3-trichlorobenzene	ND	1.0
dibromochloromethane	ND	1.0			

Surrogate Standard

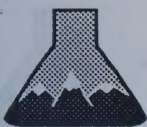
Dibromofluoromethane	126%	4-Bromofluorobenzene	113%
1,2-Dichloroethane-d4	68%	Toluene-d8	89%

Comments: ND-Parameter not detected at stated PQL.

References:

METHOD 524.2. MEASUREMENT OF PURGEABLE ORGANIC COMPOUNDS IN WATER
BY CAPILLARY COLUMN GC/MS, REVISION 3.0 (1989) USEPA

Reviewed by:



Alpine Analytical, Inc.

2814 N. Cooke, Helena, MT 59601

(406)449-6282

VOLATILE ORGANIC COMPOUNDS BLANK

Client: Hydrometrics

Date Reported: 21-Jun-99

Sample ID: BLANK

Project ID: 0054

Site ID: Helena Landfill

Laboratory ID: Blank
Sample Matrix: Water
Preservatives: HCl, Cool
Condition: Intact

Date / Time Sampled: NA
Date / Time Received: NA
Date / Time Extracted: NA
Date / Time Analyzed: 18-Jun-99 @ 14:52

Parameter	Analytical Result(ug/L)	PQL (ug/L)	Parameter	Analytical Result(ug/L)	PQL (ug/L)
dichlorodifluoromethane	ND	1.0	1,2-dibromoethane	ND	1.0
chloromethane	ND	1.0	chlorobenzene	ND	1.0
vinyl chloride	ND	1.0	1,1,1,2-tetrachloroethane	ND	1.0
bromomethane	ND	1.0	ethylbenzene	ND	1.0
chloroethane	ND	1.0	m, p-xylene	ND	1.0
trichlorofluoromethane	ND	1.0	o-xylene	ND	1.0
1,1-dichloroethene	ND	1.0	styrene	ND	1.0
methylene chloride	ND	1.0	bromoform	ND	1.0
trans-1,2-dichloroethene	ND	1.0	isopropylbenzene	ND	1.0
1,1-dichloroethane	ND	1.0	1,1,2,2-tetrachloroethane	ND	1.0
2,2-dichloropropane	ND	1.0	1,2,3-trichloropropane	ND	1.0
cis-1,2-dichloroethene	ND	1.0	n-propylbenzene	ND	1.0
chloroform	ND	1.0	bromobenzene	ND	1.0
bromochloromethane	ND	1.0	1,3,5-trimethylbenzene	ND	1.0
1,1,1-trichloroethane	ND	1.0	2-chlorotoluene	ND	1.0
1,1-dichloropropene	ND	1.0	4-chlorotoluene	ND	1.0
carbon tetrachloride	ND	1.0	tert-butylbenzene	ND	1.0
1,2-dichloroethane	ND	1.0	1,2,4-trimethylbenzene	ND	1.0
benzene	ND	1.0	sec-butylbenzene	ND	1.0
trichloroethene	ND	1.0	isopropyltoluene	ND	1.0
1,2-dichloropropane	ND	1.0	1,3-dichlorobenzene	ND	1.0
bromodichloromethane	ND	1.0	1,4-dichlorobenzene	ND	1.0
dibromomethane	ND	1.0	butylbenzene	ND	1.0
cis-1,3-dichloropropene	ND	1.0	1,2-dichlorobenzene	ND	1.0
toluene	ND	1.0	1,2-dibromo-3-chloropropane	ND	1.0
trans-1,3-dichloropropene	ND	1.0	1,2,4-trichlorobenzene	ND	1.0
1,1,2-trichloroethane	ND	1.0	hexachlorobutadiene	ND	1.0
1,3-dichloropropane	ND	1.0	naphthalene	ND	1.0
tetrachloroethene	ND	1.0	1,2,3-trichlorobenzene	ND	1.0
dibromochloromethane	ND	1.0			

Surrogate Standard

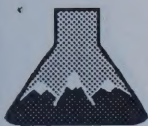
Dibromofluoromethane	105%	4-Bromofluorobenzene	69%
1,2-Dichloroethane-d4	130%	Toluene-d8	100%

Comments: ND-Parameter not detected at stated PQL.

References:

METHOD 524.2. MEASUREMENT OF PURGEABLE ORGANIC COMPOUNDS IN WATER
BY CAPILLARY COLUMN GC/MS, REVISION 3.0 (1989) USEPA

Reviewed by: 



Alpine Analytical, Inc.

2814 N. Cooke, Helena, MT 59601

(406)449-6282

VOLATILE ORGANIC COMPOUNDS LAB CONTROL

Client: Hydrometrics
Sample ID: LAB CONTROL
Project ID: 0054
Site ID: Helena Landfill

Date Reported: 21-Jun-99

Laboratory ID: Lab Control
Sample Matrix: Water
Preservatives: HCl, Cool
Condition: Intact

Date / Time Sampled: NA
Date / Time Received: NA
Date / Time Extracted: NA
Date / Time Analyzed: 18-Jun-99 @ 17:19

Parameter	Analytical Result(ug/L)	True Value	% Recovery	Parameter	Analytical Result(ug/L)	True Value	% Recovery
dichlorodifluoromethane	ND	NA	NA	1,2-dibromoethane	ND	NA	NA
chloromethane	ND	NA	NA	chlorobenzene	ND	NA	NA
vinyl chloride	ND	NA	NA	1,1,1,2-tetrachloroethane	ND	NA	NA
bromomethane	ND	NA	NA	ethylbenzene	75	69	109%
chloroethane	ND	NA	NA	m, p-xylene	19	27	70%
trichlorofluoromethane	ND	NA	NA	o-xylene	39	42	93%
1,1-dichloroethene	ND	NA	NA	styrene	ND	NA	NA
methylene chloride	ND	NA	NA	bromoform	ND	NA	NA
trans-1,2-dichloroethene	ND	NA	NA	isopropylbenzene	ND	NA	NA
1,1-dichloroethane	ND	NA	NA	1,1,2,2-tetrachloroethane	ND	NA	NA
2,2-dichloropropane	ND	NA	NA	1,2,3-trichloropropane	ND	NA	NA
cis-1,2-dichloroethene	ND	NA	NA	n-propylbenzene	ND	NA	NA
chloroform	ND	NA	NA	bromobenzene	ND	NA	NA
bromochloromethane	ND	NA	NA	1,3,5-trimethylbenzene	ND	NA	NA
1,1,1-trichloroethane	ND	NA	NA	2-chlorotoluene	ND	NA	NA
1,1-dichloropropene	ND	NA	NA	4-chlorotoluene	ND	NA	NA
carbon tetrachloride	ND	NA	NA	tert-butylbenzene	ND	NA	NA
1,2-dichloroethane	ND	NA	NA	1,2,4-trimethylbenzene	ND	NA	NA
benzene	40	39	103%	sec-butylbenzene	ND	NA	NA
trichloroethene	ND	NA	NA	isopropyltoluene	ND	NA	NA
1,2-dichloropropane	ND	NA	NA	1,3-dichlorobenzene	ND	NA	NA
bromodichloromethane	ND	NA	NA	1,4-dichlorobenzene	ND	NA	NA
dibromomethane	ND	NA	NA	butylbenzene	ND	NA	NA
cis-1,3-dichloropropene	ND	NA	NA	1,2-dichlorobenzene	ND	NA	NA
toluene	ND	NA	NA	1,2-dibromo-3-chloropropane	ND	NA	NA
trans-1,3-dichloropropene	ND	NA	NA	1,2,4-trichlorobenzene	ND	NA	NA
1,1,2-trichloroethane	ND	NA	NA	hexachlorobutadiene	ND	NA	NA
1,3-dichloropropane	ND	NA	NA	naphthalene	ND	NA	NA
tetrachloroethene	ND	NA	NA	1,2,3-trichlorobenzene	ND	NA	NA
dibromochloromethane	ND	NA	NA				

Surrogate Standard

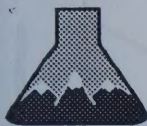
Dibromofluoromethane	70%	4-Bromofluorobenzene	78%
1,2-Dichloroethane-d4	66%	Toluene-d8	72%

Comments: ND-Parameter not detected at stated PQL.

References:

METHOD 524.2. MEASUREMENT OF PURGEABLE ORGANIC COMPOUNDS IN WATER
BY CAPILLARY COLUMN GC/MS, REVISION 3.0 (1989) USEPA

Reviewed by:



Alpine Analytical, Inc.

2814 N. Cooke, Helena, MT 59601

(406)499-6282

VOLATILE ORGANIC COMPOUNDS MATRIX DUPLICATE

Client: Hydrometrics

Date Reported: 21-Jun-99

Sample ID: LAB CONTROL DUPLICATE

Project ID: 0054

Site ID: Helena Landfill

Laboratory ID: Lab Control-Dup

Date / Time Sampled: NA

Sample Matrix: Water

Date / Time Received: NA

Preservatives: HCl, Cool

Date / Time Extracted: NA

Condition: Intact

Date / Time Analyzed: 18-Jun-99 @ 20:16

Parameter	Analytical Result(ug/L)	Dup. Result	% Relative Difference	Parameter	Analytical Result(ug/L)	Dup. Result	% Relative Difference
dichlorodifluoromethane	ND	NA	NA	1,2-dibromoethane	ND	NA	NA
chloromethane	ND	NA	NA	chlorobenzene	ND	NA	NA
vinyl chloride	ND	NA	NA	1,1,1,2-tetrachloroethane	ND	NA	NA
bromomethane	ND	NA	NA	ethylbenzene	75	71	5%
chloroethane	ND	NA	NA	m, p-xylene	19	15	21%
trichlorofluoromethane	ND	NA	NA	o-xylene	39	34	13%
1,1-dichloroethene	ND	NA	NA	styrene	ND	NA	NA
methylene chloride	ND	NA	NA	bromoform	ND	NA	NA
trans-1,2-dichloroethene	ND	NA	NA	isopropylbenzene	ND	NA	NA
1,1-dichloroethane	ND	NA	NA	1,1,2,2-tetrachloroethane	ND	NA	NA
2,2-dichloropropane	ND	NA	NA	1,2,3-trichloropropane	ND	NA	NA
cis-1,2-dichloroethene	ND	NA	NA	n-propylbenzene	ND	NA	NA
chloroform	ND	NA	NA	bromobenzene	ND	NA	NA
bromochloromethane	ND	NA	NA	1,3,5-trimethylbenzene	ND	NA	NA
1,1,1-trichloroethane	ND	NA	NA	2-chlorotoluene	ND	NA	NA
1,1-dichloropropene	ND	NA	NA	4-chlorotoluene	ND	NA	NA
carbon tetrachloride	ND	NA	NA	tert-butylbenzene	ND	NA	NA
1,2-dichloroethane	ND	NA	NA	1,2,4-trimethylbenzene	ND	NA	NA
benzene	40	42	5%	sec-butylbenzene	ND	NA	NA
trichloroethene	ND	NA	NA	isopropyltoluene	ND	NA	NA
1,2-dichloropropane	ND	NA	NA	1,3-dichlorobenzene	ND	NA	NA
bromodichloromethane	ND	NA	NA	1,4-dichlorobenzene	ND	NA	NA
dibromomethane	ND	NA	NA	butylbenzene	ND	NA	NA
cis-1,3-dichloropropene	ND	NA	NA	1,2-dichlorobenzene	ND	NA	NA
toluene	ND	NA	NA	1,2-dibromo-3-chloropropane	ND	NA	NA
trans-1,3-dichloropropene	ND	NA	NA	1,2,4-trichlorobenzene	ND	NA	NA
1,1,2-trichloroethane	ND	NA	NA	hexachlorobutadiene	ND	NA	NA
1,3-dichloropropane	ND	NA	NA	naphthalene	ND	NA	NA
tetrachloroethene	ND	NA	NA	1,2,3-trichlorobenzene	ND	NA	NA
dibromochloromethane	ND	NA	NA				

Surrogate Standard

Dibromofluoromethane	73%	4-Bromofluorobenzene	99%
1,2-Dichloroethane-d4	98%	Toluene-d8	62%

Comments:

References:

METHOD 524.2. MEASUREMENT OF PURGEABLE ORGANIC COMPOUNDS IN WATER
BY CAPILLARY COLUMN GC/MS, REVISION 3.0 (1989) USEPA

Reviewed by: 

2727 Airport Road • Helena, Montana 59601 • (406) 443-4150

[illegible]

STANDARD OPERATING PROCEDURE WATER SAMPLING FORM HF-FORM-430

Consulting Scientists,
Engineers and ContractorsProject Name: CHHLProject Code: 0054Sample Team Member(s): D.S.L.H.Laboratory Used: EnergySite Designation: H1-99-1Sample Code Number: CHHL-9906-100Sample Date: 6/28/99Sample Time: 1540 (military)

If Duplicate Sample Collected,
Please Record Below

Duplicate Sample Code #: _____

Duplicate Sample Time: _____

Site ConditionsNew Site: ☒ Yes ☐ No Photo taken: ☐ Yes ☒ NoSite Type: DRY surface water process watermonitoring well domestic well adit seep

spring other: _____

Weather Conditions: calm breeze windyno precip. rain snowclear p. cloudy overcastAir Temperature: 20 °C °F**For Groundwater Samples**

well volume formula:	$V = (TD-SWL) \times (Dia.^2) / 25$	Comments
TD (ft):	<u>100'</u>	no access/pumping MP-Top of steel
SWL (ft):	<u>56.70'</u>	
Casing Diameter (I.D.):	<u>6"</u>	
Water Volume (V) (gal):	<u>62</u>	
x 3=(gal.)	<u>187</u>	
Actual Vol. Removed (gal.)	<u>187</u>	
Water Level Recovery:	slow <u>moderate</u> rapid	

For Surface Water Samples

Flow Method:	Marsh McBirney Volumetric <u>/</u> Flume Weir Estimate
Other Flow or Description:	_____
Flow:	gpm cfs Staff Gage: _____

Field Parameter Stabilization

Time (military)	Oxidation Reduction Potential (mV)	Dissolved Oxygen (mg/l)	pH	S.C. (µmhos/cm)	Turbidity (n.t.u.)	Temperature (°C)	Additional Parameters or Notes

Turbidity: (circle)

clear slight

moderate very

Sample Method: (describe)

grab

composite

pumpbailer

other

4" sub pump Disp. Bailer**Field Parameters**

Sample Duplicate

ORP (mV)

DO (mg/l)

pH

SC (µmhos/cm)

Turbidity (ntu)

H₂O Tmp. (°C)

Color

TAN

Other: _____

Bottles Collected

Quantity	Size	Filter or Unfilt.	Preservative	Parameter	Additional Notes
<u>2</u>	<u>40</u> ml	F or <u>UF</u>	<u>HCL</u>	<u>DOC</u>	
	ml	F or UF			
	ml	F or UF			
	ml	F or UF			
	ml	F or UF			
	ml	F or UF			
	ml	F or UF			
	ml	F or UF			
	ml	F or UF			

Comments: Sample collected with Disp. BailerSWL Dropped approx 2.0' @ 8.5 gpmpumped 22 minsSample Team Member Signature: D.S.L.H.

Page _____ of _____

STANDARD OPERATING PROCEDURE WATER SAMPLING FORM HF-FORM-430

Consulting Scientists,
Engineers and ContractorsProject Name: CHHLProject Code: 0054Sample Team Member(s): D.S. & L.Laboratory Used: EnergySite Designation: HL-99-2Sample Code Number: CHHL-9906-101Sample Date: 6/28/99Sample Time: 1635 (military)

If Duplicate Sample Collected,
Please Record Below

Duplicate Sample Code #: _____

Duplicate Sample Time: _____

Site ConditionsNew Site: ☒ Yes ☐ No Photo taken: ☐ Yes ☒ NoSite Type: ☒ DRY ☐ surface water ☐ process water☒ monitoring well ☐ domestic well ☐ adit ☐ seep

spring other: _____

Weather Conditions: ☒ calm ☐ breeze ☒ windy☒ no precip. ☐ rain ☐ snow☐ clear ☒ p. cloudy ☐ overcastAir Temperature: 20 °C °F**For Groundwater Samples**

well volume formula:	$V = (TD-SWL) \times (\text{Dia.}^2) / 25$	Comments
TD (ft):	<u>120</u>	no access/pumping mp-top of steel
SWL (ft):	<u>57.75</u>	
Casing Diameter (I.D.):	<u>6"</u>	
Water Volume (V) (gal):	<u>89</u>	
x 3=(gal.)	<u>269</u>	
Actual Vol. Removed (gal.):	<u>270</u>	
Water Level Recovery:	slow ☒ moderate ☐ rapid	

For Surface Water Samples

Flow Method:	☒ Marsh McBirney ☐ Volumetric ☐ Flume ☐ Weir ☐ Estimate
Other Flow or Description:	_____
Flow:	gpm cfs Staff Gage: _____

Field Parameter Stabilization

Time (military)	Oxidation Reduction Potential (mV)	Dissolved Oxygen (mg/l)	pH	S.C. (µmhos/cm)	Turbidity (n.t.u.)	Temperature (°C)	Additional Parameters or Notes

Turbidity: (circle) ☐ clear ☒ moderate ☐ slight ☐ very

Sample Method: (describe) ☒ grab ☐ composite ☒ pump ☒ bailer ☐ other

4" Sub pump / Disp.

Field Parameters

Sample	Duplicate
ORP (mV)	
DO (mg/l)	
pH	
SC (µmhos/cm)	
Turbidity (ntu)	
H ₂ O Tmp. (°C)	
Color	<u>Lt Orange</u>
Other:	

Bottles Collected

Quantity	Size	Filter or Unfilt.	Preservative	Parameter	Additional Notes
<u>2</u>	<u>40</u> ml	F or ☒ UF	<u>HCL</u>	<u>VOC</u>	
	ml	F or UF			
	ml	F or UF			
	ml	F or UF			
	ml	F or UF			
	ml	F or UF			
	ml	F or UF			
	ml	F or UF			
	ml	F or UF			

Comments: Sample collected with Disp. Bailer

Sec Dropped approx 5.0' @ 7.5 gpm 36 mins of pumping

Sample Team Member Signature: _____ Page _____ of _____

STANDARD OPERATING PROCEDURE
WATER SAMPLING FORM
HF-FORM-430Consulting Scientists,
Engineers and Contractors

Project Name: CHHL
Project Code: 0054
Sample Team Member(s): R.S. Loh
Laboratory Used: Energy

Site Designation: HL-99-3
Sample Code Number: CHHL-9906-102R
Sample Date: 6/28/99
Sample Time: 1730 (military)

If Duplicate Sample Collected,
Please Record Below

Duplicate Sample Code #: _____
Duplicate Sample Time: _____

Site Conditions

New Site: ☒ Yes ☐ No Photo taken: ☐ Yes ☒ No
Site Type: DRY surface water process water
monitoring well domestic well adit seep
spring other: _____

Weather Conditions: calm breeze windy
no precip. rain snow
clear b. cloudy overcast

Air Temperature: 20 °C °F

For Groundwater Samples

well volume formula:	$V = (TD-SWL) \times (\text{Dia.}^2) / 25$	Comments
TD (ft):	<u>100</u>	
SWL (ft):	<u>53.15</u>	no access/pumping
Casing Diameter (I.D.):	<u>6"</u>	MP-TOP of steel
Water Volume (V) (gal):	<u>67</u>	
x 3=(gal.)	<u>201</u>	
Actual Vol. Removed (gal.):	<u>201</u>	
Water Level Recovery:	slow <u>moderate</u> rapid	

For Surface Water Samples

Flow Method: Marsh McBirney Volumetric Flume Weir Estimate
Other Flow or Description: _____
Flow: _____ gpm cfs Staff Gage: _____

Field Parameter Stabilization

Time (military)	Oxidation Reduction Potential (mV)	Dissolved Oxygen (mg/l)	pH	S.C. (µmhos/cm)	Turbidity (n.t.u.)	Temperature (°C)	Additional Parameters or Notes

Turbidity: clear slight moderate very

Sample Method: grab composite pump bailer other
(describe) 4" Sub Pump / Disp

Field Parameters

Sample Duplicate

ORP (mV)

DO (mg/l)

pH

SC (µmhos/cm)

Turbidity (ntu)

H₂O Tmp. (°C)

Color

Other: _____

Lt. Orange

Quantity	Size	Filter or Unfilt.	Preservative	Parameter	Additional Notes
<u>2</u>	<u>40</u> ml	F or <u>UF</u>	<u>HCL</u>	<u>DOC</u>	
	ml	F or UF			
	ml	F or UF			
	ml	F or UF			
	ml	F or UF			
	ml	F or UF			
	ml	F or UF			
	ml	F or UF			
	ml	F or UF			
	ml	F or UF			

Comments: Sample collected with Disp Bailer
SWL Dropped Approx. 40' @ 8 gpm for 25 min

Sample Team Member Signature: [Signature]

Page _____ of _____

EPA METHOD 8260AClient: **Hydrometrics**
Sample ID: **CHHL-9906-100**
Project Info: **PROJ. #0054, HELENA LANDFILL**
Lab ID: **001-99-54235**
Matrix: **WATER**Date Reported: **07/05/99**
Date Sampled: **6/28/99 15:40**
Date Received: **06/30/99**
Date Analyzed: **7/1/99 23:00**

HL-99-1

C.A.S. #	TARGET COMPOUNDS	CONCENTRATION ($\mu\text{g/L}$)	LIMIT OF QUANTITATION($\mu\text{g/L}$)
67-64-1	Acetone	904D	20
107-13-1	Acrylonitrile	ND	20
71-43-2	Benzene	ND	1.0
74-97-5	Bromochloromethane	ND	1.0
75-27-4	Bromodichloromethane	ND	1.0
75-25-2	Bromoform	ND	1.0
74-83-9	Bromomethane	ND	1.0
75-15-0	Carbon disulfide	ND	1.0
56-23-5	Carbon tetrachloride	ND	1.0
108-90-7	Chlorobenzene	ND	1.0
124-48-1	Chlorodibromomethane	ND	1.0
75-00-3	Chloroethane	ND	1.0
67-66-3	Chloroform	2.8	1.0
74-87-3	Chloromethane	ND	1.0
96-12-8	1,2-Dibromo-3-chloropropane	ND	1.0
106-93-4	1,2-Dibromoethane	ND	1.0
74-95-3	Dibromomethane	ND	1.0
95-50-1	1,2-Dichlorobenzene	ND	1.0
106-46-7	1,4-Dichlorobenzene	ND	1.0
110-57-6	trans-1,4-Dichloro-2-butene	ND	2.0
75-71-8	Dichlorodifluoromethane	1.7	1.0
75-34-3	1,1-Dichloroethane	1.5	1.0
107-06-2	1,2-Dichloroethane	ND	1.0
75-35-4	1,1-Dichloroethene	ND	1.0
156-59-2	cis-1,2-Dichloroethene	1.1	1.0
156-60-5	trans-1,2-Dichloroethene	ND	1.0
78-87-5	1,2-Dichloropropane	ND	1.0
10061-01-5	cis-1,3-Dichloropropene	ND	1.0
10061-02-6	trans-1,3-Dichloropropene	ND	1.0
100-41-4	Ethylbenzene	ND	1.0
591-78-6	2-Hexanone	ND	20
74-88-4	Iodomethane	ND	1.0
78-93-3	Methyl ethyl ketone	(19)J	20
108-10-1	Methyl isobutyl ketone	ND	20
75-09-2	Methylene chloride	(0.31)J	1.0
100-42-5	Styrene	ND	1.0
630-20-6	1,1,1,2-Tetrachloroethane	ND	1.0
79-34-5	1,1,2,2-Tetrachloroethane	ND	1.0
127-18-4	Tetrachloroethene	8.2	1.0
108-88-3	Toluene	ND	1.0
71-55-6	1,1,1-Trichloroethane	(0.99)J	1.0
79-00-5	1,1,2-Trichloroethane	ND	1.0
79-01-6	Trichloroethene	(0.91)J	1.0
75-69-4	Trichlorofluoromethane	(0.45)J	1.0
96-18-4	1,2,3-Trichloropropane	ND	1.0

ENERGY

ENERGY LABORATORIES, INC.

EPA METHOD 8260A(Continued)

Client: **Hydrometrics**
Sample ID: **CHHL-9906-100**

Date Reported: **7/5/99**
Lab ID: **001-99-54235**

C.A.S. #	TARGET COMPOUNDS	CONCENTRATION ($\mu\text{g/L}$)	LIMIT OF QUANTITATION($\mu\text{g/L}$)
108-05-4	Vinyl acetate	ND	1.0
75-01-4	Vinyl chloride	ND	1.0
108383/106423	m+p-Xylenes	ND	1.0
95-47-6	o-Xylene	ND	1.0

ND= Indicates compound was analyzed for but not detected.

D= Value was derived from a 10 times dilution.

J= Estimated value. Present, but less than the limit of quantitation.

Runtime Quality Assurance Report

SYSTEM MONITORING COMPOUNDS	CONCENTRATION($\mu\text{g/L}$)		PERCENT RECOVERY	ACCEPTANCE RANGE
	ADDED	MEASURED		
1,2-Dichloroethane d4	10	11.8	118	80-120
Toluene d8	10	10.3	103	80-120
p-Bromofluorobenzene	10	9.32	93	80-120

REPORT COMMENTS: None

Analyst: Reviewing Supervisor: /chem/5971A.l/va070199.b/jul011501015.d

EPA METHOD 8260AClient: **Hydrometrics**
Sample ID: **CHHL-9906-101**
Project Info: **PROJ. #0054, HELENA LANDFILL**
Lab ID: **002-99-54235**
Matrix: **WATER**

HL-99-2

Date Reported: **07/05/99**
Date Sampled: **6/28/99 16:35**
Date Received: **06/30/99**
Date Analyzed: **7/1/99 19:23**

C.A.S. #	TARGET COMPOUNDS	CONCENTRATION	LIMIT OF
		($\mu\text{g/L}$)	QUANTITATION($\mu\text{g/L}$)
67-64-1	Acetone	(16)J	20
107-13-1	Acrylonitrile	ND	20
71-43-2	Benzene	ND	1.0
74-97-5	Bromochloromethane	ND	1.0
75-27-4	Bromodichloromethane	ND	1.0
75-25-2	Bromoform	ND	1.0
74-83-9	Bromomethane	ND	1.0
75-15-0	Carbon disulfide	ND	1.0
56-23-5	Carbon tetrachloride	ND	1.0
108-90-7	Chlorobenzene	ND	1.0
124-48-1	Chlorodibromomethane	ND	1.0
75-00-3	Chloroethane	ND	1.0
67-66-3	Chloroform	1.6	1.0
74-87-3	Chloromethane	ND	1.0
96-12-8	1,2-Dibromo-3-chloropropane	ND	1.0
106-93-4	1,2-Dibromoethane	ND	1.0
74-95-3	Dibromomethane	ND	1.0
95-50-1	1,2-Dichlorobenzene	ND	1.0
106-46-7	1,4-Dichlorobenzene	ND	1.0
110-57-6	trans-1,4-Dichloro-2-butene	ND	2.0
75-71-8	Dichlorodifluoromethane	(0.82)J	1.0
75-34-3	1,1-Dichloroethane	1.2	1.0
107-06-2	1,2-Dichloroethane	ND	1.0
75-35-4	1,1-Dichloroethene	ND	1.0
156-59-2	cis-1,2-Dichloroethene	(0.32)J	1.0
156-60-5	trans-1,2-Dichloroethene	ND	1.0
78-87-5	1,2-Dichloropropane	ND	1.0
10061-01-5	cis-1,3-Dichloropropene	ND	1.0
10061-02-6	trans-1,3-Dichloropropene	ND	1.0
100-41-4	Ethylbenzene	ND	1.0
591-78-6	2-Hexanone	ND	20
74-88-4	Iodomethane	ND	1.0
78-93-3	Methyl ethyl ketone	ND	20
108-10-1	Methyl isobutyl ketone	ND	20
75-09-2	Methylene chloride	(0.89)J	1.0
100-42-5	Styrene	ND	1.0
630-20-6	1,1,1,2-Tetrachloroethane	ND	1.0
79-34-5	1,1,2,2-Tetrachloroethane	ND	1.0
127-18-4	Tetrachloroethene	4.1	1.0
108-88-3	Toluene	ND	1.0
71-55-6	1,1,1-Trichloroethane	(0.59)J	1.0
79-00-5	1,1,2-Trichloroethane	ND	1.0
79-01-6	Trichloroethene	(0.48)J	1.0
75-69-4	Trichlorofluoromethane	(0.21)J	1.0
96-18-4	1,2,3-Trichloropropane	ND	1.0

EPA METHOD 8260A(Continued)

Client: **Hydrometrics**
Sample ID: **CHHL-9906-101**

Date Reported: **7/5/99**
Lab ID: **002-99-54235**

C.A.S. #	TARGET COMPOUNDS	CONCENTRATION ($\mu\text{g/L}$)	LIMIT OF QUANTITATION($\mu\text{g/L}$)
108-05-4	Vinyl acetate	ND	1.0
75-01-4	Vinyl chloride	ND	1.0
108383/106423	m+p-Xylenes	ND	1.0
95-47-6	o-Xylene	ND	1.0

ND= Indicates compound was analyzed for but not detected.

J= Estimated value. Present, but less than the limit of quantitation.

Runtime Quality Assurance Report

SYSTEM MONITORING COMPOUNDS	CONCENTRATION($\mu\text{g/L}$)		PERCENT	ACCEPTANCE
	ADDED	MEASURED	RECOVERY	RANGE
1,2-Dichloroethane d4	10	10.8	108	80-120
Toluene d8	10	10.2	102	80-120
p-Bromofluorobenzene	10	9.04	90	80-120

REPORT COMMENTS: None

Analyst: C Reviewing Supervisor: MD /chem/5971A.iva070199.b/jul010901009.d

EPA METHOD 8260A

Client: Hydrometrics
Sample ID: CHHL-9906-102
Project Info: PROJ. #0054, HELENA LANDFILL
Lab ID: 003-99-54235
Matrix: WATER

HL-99-3

Date Reported: 07/05/99
Date Sampled: 6/28/99 17:30
Date Received: 06/30/99
Date Analyzed: 7/1/99 23:34

C.A.S. #	TARGET COMPOUNDS	CONCENTRATION ($\mu\text{g/L}$)	LIMIT OF QUANTITATION($\mu\text{g/L}$)
67-64-1	Acetone	(18)J	20
107-13-1	Acrylonitrile	ND	20
71-43-2	Benzene	(0.18)J	1.0
74-97-5	Bromochloromethane	ND	1.0
75-27-4	Bromodichloromethane	ND	1.0
75-25-2	Bromoform	ND	1.0
74-83-9	Bromomethane	ND	1.0
75-15-0	Carbon disulfide	ND	1.0
56-23-5	Carbon tetrachloride	ND	1.0
108-90-7	Chlorobenzene	ND	1.0
124-48-1	Chlorodibromomethane	ND	1.0
75-00-3	Chloroethane	ND	1.0
67-86-3	Chloroform	1.7	1.0
74-87-3	Chloromethane	ND	1.0
96-12-8	1,2-Dibromo-3-chloropropane	ND	1.0
106-93-4	1,2-Dibromoethane	ND	1.0
74-95-3	Dibromomethane	ND	1.0
95-50-1	1,2-Dichlorobenzene	ND	1.0
106-46-7	1,4-Dichlorobenzene	ND	1.0
110-57-6	trans-1,4-Dichloro-2-butene	ND	2.0
75-71-8	Dichlorodifluoromethane	5.7	1.0
75-34-3	1,1-Dichloroethane	4.3	1.0
107-06-2	1,2-Dichloroethane	ND	1.0
75-35-4	1,1-Dichloroethene	(0.24)J	1.0
156-59-2	cis-1,2-Dichloroethene	(0.37)J	1.0
156-60-5	trans-1,2-Dichloroethene	ND	1.0
78-87-5	1,2-Dichloropropane	ND	1.0
10061-01-5	cis-1,3-Dichloropropene	ND	1.0
10061-02-6	trans-1,3-Dichloropropene	ND	1.0
100-41-4	Ethylbenzene	ND	1.0
591-78-6	2-Hexanone	ND	20
74-88-4	Iodomethane	ND	1.0
78-93-3	Methyl ethyl ketone	ND	20
108-10-1	Methyl isobutyl ketone	ND	20
75-09-2	Methylene chloride	7.2	1.0
100-42-5	Styrene	(0.39)J	1.0
630-20-6	1,1,1,2-Tetrachloroethane	ND	1.0
79-34-5	1,1,2,2-Tetrachloroethane	ND	1.0
127-18-4	Tetrachloroethene	19	1.0
108-88-3	Toluene	ND	1.0
71-55-6	1,1,1-Trichloroethane	3.2	1.0
79-00-5	1,1,2-Trichloroethane	ND	1.0
79-01-6	Trichloroethene	1.9	1.0
75-69-4	Trichlorofluoromethane	3.2	1.0
96-18-4	1,2,3-Trichloropropane	ND	1.0

EPA METHOD 8260A(Continued)

Client: **Hydrometrics**
Sample ID: **CHHL-9906-102**

Date Reported: **7/5/99**
Lab ID: **003-99-54235**

C.A.S. #	TARGET COMPOUNDS	CONCENTRATION (µg/L)	LIMIT OF QUANTITATION(µg/L)
108-05-4	Vinyl acetate	ND	1.0
75-01-4	Vinyl chloride	ND	1.0
108383/106423	m+p-Xylenes	ND	1.0
95-47-6	o-Xylene	ND	1.0

ND= Indicates compound was analyzed for but not detected.

J= Estimated value. Present, but less than the limit of quantitation.

Runtime Quality Assurance Report

SYSTEM MONITORING COMPOUNDS	CONCENTRATION(µg/L)		PERCENT	ACCEPTANCE
	ADDED	MEASURED	RECOVERY	RANGE
1,2-Dichloroethane d4	10	11.5	115	80-120
Toluene d8	10	10.2	102	80-120
p-Bromofluorobenzene	10	9.16	92	80-120

REPORT COMMENTS: None

Analyst:

Reviewing Supervisor:

/chem/5971A.i/va070199.b/jul011601016.d

QUALITY ASSURANCE REPORT FOR EPA METHOD 8260A: METHOD BLANK

Sample ID: Quality Assurance Method Blank
Matrix: WATER
Extract Method: EPA 5030

Date Reported: 07/05/99
Date Analyzed: 7/1/99 18:33

C.A.S. #	TARGET COMPOUNDS	CONCENTRATION (µg/L)	LIMIT OF QUANTITATION(µg/L)
67-64-1	Acetone	ND	20
107-13-1	Acrylonitrile	ND	20
71-43-2	Benzene	ND	1.0
74-97-5	Bromochloromethane	ND	1.0
75-27-4	Bromodichloromethane	ND	1.0
75-25-2	Bromoform	ND	1.0
74-83-9	Bromomethane	ND	1.0
75-15-0	Carbon disulfide	ND	1.0
56-23-5	Carbon tetrachloride	ND	1.0
108-90-7	Chlorobenzene	ND	1.0
124-48-1	Chlorodibromomethane	ND	1.0
75-00-3	Chloroethane	ND	1.0
67-66-3	Chloroform	ND	1.0
74-87-3	Chloromethane	ND	1.0
96-12-8	1,2-Dibromo-3-chloropropane	ND	1.0
106-93-4	1,2-Dibromoethane	ND	1.0
74-95-3	Dibromomethane	ND	1.0
95-50-1	1,2-Dichlorobenzene	ND	1.0
106-46-7	1,4-Dichlorobenzene	ND	1.0
110-57-6	trans-1,4-Dichloro-2-butene	ND	2.0
75-71-8	Dichlorodifluoromethane	ND	1.0
75-34-3	1,1-Dichloroethane	ND	1.0
107-06-2	1,2-Dichloroethane	ND	1.0
75-35-4	1,1-Dichloroethene	ND	1.0
156-59-2	cis-1,2-Dichloroethene	ND	1.0
156-60-5	trans-1,2-Dichloroethene	ND	1.0
78-87-5	1,2-Dichloropropane	ND	1.0
10061-01-5	cis-1,3-Dichloropropene	ND	1.0
10061-02-6	trans-1,3-Dichloropropene	ND	1.0
100-41-4	Ethylbenzene	ND	1.0
591-78-6	2-Hexanone	ND	20
74-88-4	Iodomethane	ND	1.0
78-93-3	Methyl ethyl ketone	ND	20
108-10-1	Methyl isobutyl ketone	ND	20
75-09-2	Methylene chloride	ND	1.0
100-42-5	Styrene	ND	1.0
630-20-6	1,1,1,2-Tetrachloroethane	ND	1.0
79-34-5	1,1,2,2-Tetrachloroethane	ND	1.0
127-18-4	Tetrachloroethene	ND	1.0
108-88-3	Toluene	ND	1.0
71-55-6	1,1,1-Trichloroethane	ND	1.0
79-00-5	1,1,2-Trichloroethane	ND	1.0
79-01-6	Trichloroethene	ND	1.0
75-69-4	Trichlorofluoromethane	ND	1.0
96-18-4	1,2,3-Trichloropropane	ND	1.0

QUALITY ASSURANCE REPORT FOR EPA METHOD 8260A: METHOD BLANK (Continued)

Sample ID: Quality Assurance Method Blank
Matrix: WATER

Date Reported: 07/05/99
Date Analyzed:

C.A.S. #	TARGET COMPOUNDS	CONCENTRATION ($\mu\text{g/L}$)	LIMIT OF QUANTITATION($\mu\text{g/L}$)
108-05-4	Vinyl acetate	ND	1.0
75-01-4	Vinyl chloride	ND	1.0
108383/106423	m+p-Xylenes	ND	1.0
95-47-6	o-Xylene	ND	1.0

ND= Indicates compound was analyzed for but not detected.

Runtime Quality Assurance Report

SYSTEM MONITORING COMPOUNDS	CONCENTRATION($\mu\text{g/L}$)		PERCENT RECOVERY	ACCEPTANCE RANGE
	ADDED	MEASURED		
1,2-Dichloroethane d4	10	11.5	115	80-120
Toluene d8	10	9.98	100	80-120
p-Bromofluorobenzene	10	9.61	96	80-120

REPORT COMMENTS: None

Analyst: CS Reviewing Supervisor: mg /chem/5971A.i/va070199.b/jul010801008.d

QUALITY ASSURANCE REPORT FOR EPA METHOD 8260A: METHOD BLANK

Sample ID: Quality Assurance Method Blank
 Matrix: WATER
 Extract Method: EPA 5030

Date Reported: 07/05/99
 Date Analyzed: 7/1/99 22:25

C.A.S. #	TARGET COMPOUNDS	CONCENTRATION (µg/L)	LIMIT OF QUANTITATION(µg/L)
67-64-1	Acetone	ND	20
107-13-1	Acrylonitrile	ND	20
71-43-2	Benzene	ND	1.0
74-97-5	Bromochloromethane	ND	1.0
75-27-4	Bromodichloromethane	ND	1.0
75-25-2	Bromoform	ND	1.0
74-83-9	Bromomethane	ND	1.0
75-15-0	Carbon disulfide	ND	1.0
56-23-5	Carbon tetrachloride	ND	1.0
108-90-7	Chlorobenzene	ND	1.0
124-48-1	Chlorodibromomethane	ND	1.0
75-00-3	Chloroethane	ND	1.0
67-66-3	Chloroform	ND	1.0
74-87-3	Chloromethane	ND	1.0
96-12-8	1,2-Dibromo-3-chloropropane	ND	1.0
106-93-4	1,2-Dibromoethane	ND	1.0
74-95-3	Dibromomethane	ND	1.0
95-50-1	1,2-Dichlorobenzene	ND	1.0
106-46-7	1,4-Dichlorobenzene	ND	1.0
110-57-6	trans-1,4-Dichloro-2-butene	ND	2.0
75-71-8	Dichlorodifluoromethane	ND	1.0
75-34-3	1,1-Dichloroethane	ND	1.0
107-06-2	1,2-Dichloroethane	ND	1.0
75-35-4	1,1-Dichloroethene	ND	1.0
156-59-2	cis-1,2-Dichloroethene	ND	1.0
156-60-5	trans-1,2-Dichloroethene	ND	1.0
78-87-5	1,2-Dichloropropane	ND	1.0
10061-01-5	cis-1,3-Dichloropropene	ND	1.0
10061-02-6	trans-1,3-Dichloropropene	ND	1.0
100-41-4	Ethylbenzene	ND	1.0
591-78-6	2-Hexanone	ND	20
74-88-4	Iodomethane	ND	1.0
78-93-3	Methyl ethyl ketone	ND	20
108-10-1	Methyl isobutyl ketone	ND	20
75-09-2	Methylene chloride	ND	1.0
100-42-5	Styrene	ND	1.0
630-20-6	1,1,1,2-Tetrachloroethane	ND	1.0
79-34-5	1,1,2,2-Tetrachloroethane	ND	1.0
127-18-4	Tetrachloroethene	ND	1.0
108-88-3	Toluene	ND	1.0
71-55-6	1,1,1-Trichloroethane	ND	1.0
79-00-5	1,1,2-Trichloroethane	ND	1.0
79-01-6	Trichloroethene	ND	1.0
75-69-4	Trichlorofluoromethane	ND	1.0
96-18-4	1,2,3-Trichloropropane	ND	1.0

QUALITY ASSURANCE REPORT FOR EPA METHOD 8260A: METHOD BLANK (Continued)

Sample ID: Quality Assurance Method Blank
Matrix: WATER

Date Reported: 07/05/99
Date Analyzed:

C.A.S. #	TARGET COMPOUNDS	CONCENTRATION ($\mu\text{g/L}$)	LIMIT OF QUANTITATION($\mu\text{g/L}$)
108-05-4	Vinyl acetate	ND	1.0
75-01-4	Vinyl chloride	ND	1.0
108383/106423	m+p-Xylenes	ND	1.0
95-47-6	o-Xylene	ND	1.0

ND= Indicates compound was analyzed for but not detected.

Runtime Quality Assurance Report

SYSTEM MONITORING COMPOUNDS	CONCENTRATION($\mu\text{g/L}$)		PERCENT	ACCEPTANCE RANGE
	ADDED	MEASURED	RECOVERY	
1,2-Dichloroethane d4	10	11.8	118	80-120
Toluene d8	10	10.4	104	80-120
p-Bromofluorobenzene	10	9.16	92	80-120

REPORT COMMENTS: None

Analyst: GO Reviewing Supervisor: mtj /chem/5971A.lva070199.b/jul011401014.d

QUALITY ASSURANCE REPORT FOR EPA METHOD 8260A: REFERENCE STANDARD BLANK MATRIX SPIKE

Sample ID: Quality Assurance Blank Matrix Spike
 Matrix: WATER
 Extract Method: EPA 5030

Date Reported: 07/05/99
 Date Analyzed: 6/29/99 10:55

SPIKE COMPOUNDS	CONCENTRATION(μ g/L)		PERCENT RECOVERY	ACCEPTANCE RANGE
	ADDED	MEASURED		
Acetone	50	43.9	88	60-140
Benzene	5.00	5.39	108	60-140
Bromochloromethane	5.00	5.85	117	60-140
Bromodichloromethane	5.00	4.91	98	60-140
Bromoform	5.00	5.08	102	60-140
Bromomethane	5.00	4.49	90	60-140
Carbon tetrachloride	5.00	5.53	111	60-140
Chlorobenzene	5.00	5.10	102	60-140
Chlorodibromomethane	5.00	4.93	99	60-140
Chloroethane	5.00	5.62	112	60-140
Chloroform	5.00	5.50	110	60-140
Chloromethane	5.00	5.88	118	60-140
1,2-Dibromo-3-chloropropane	5.00	4.30	86	60-140
1,2-Dibromoethane	5.00	4.87	97	60-140
Dibromomethane	5.00	5.08	102	60-140
1,2-Dichlorobenzene	5.00	4.71	94	60-140
1,4-Dichlorobenzene	5.00	4.90	98	60-140
Dichlorodifluoromethane	5.00	6.02	120	60-140
1,1-Dichloroethane	5.00	5.73	115	60-140
1,1-Dichloroethene	5.00	5.91	118	60-140
cis-1,2-Dichloroethene	5.00	5.55	111	60-140
trans-1,2-Dichloroethene	5.00	5.74	115	60-140
1,2-Dichloropropane	5.00	4.49	90	60-140
cis-1,3-Dichloropropene	5.00	5.37	107	60-140
trans-1,3-Dichloropropene	5.00	4.85	97	60-140
Ethylbenzene	5.00	5.19	104	60-140
2-Hexanone	50	45.3	91	60-140
Methyl ethyl ketone	50	44.7	89	60-140
Methyl isobutyl ketone	50	42.2	84	60-140
Methylene chloride	5.00	5.39	108	60-140
Styrene	5.00	5.10	102	60-140
1,1,1,2-Tetrachloroethane	5.00	5.13	103	60-140
1,1,2,2-Tetrachloroethane	5.00	4.26	85	60-140
Tetrachloroethene	5.00	5.75	115	60-140
Toluene	5.00	5.06	101	60-140
1,1,1-Trichloroethane	5.00	5.40	108	60-140
1,1,2-Trichloroethane	5.00	4.84	97	60-140
Trichloroethene	5.00	5.40	108	60-140
Trichlorofluoromethane	5.00	4.88	98	60-140
1,2,3-Trichloropropane	5.00	4.42	88	60-140
Vinyl chloride	5.00	5.37	107	60-140
m+p-Xylenes	10	10.6	106	60-140
o-Xylene	5.00	5.08	102	60-140

Runtime Quality Assurance Report

SYSTEM MONITORING COMPOUNDS	CONCENTRATION(μ g/L)		PERCENT RECOVERY	ACCEPTANCE RANGE
	ADDED	MEASURED		
1,2-Dichloroethane d4	10	10.3	103	80-120
Toluene d8	10	10.5	105	80-120
p-Bromofluorobenzene	10	9.63	96	80-120

REPORT COMMENTS: None

Analyst: 

Reviewing Supervisor: 

/chem/5971A.i/va062999.b/jun290301003.d

Lab Nos.: 001-99-54235 - 003-99-54235

Date: 30-JUN-99

Received by: Krystal McDonald

Logged In by: Krystal McDonald

SAMPLE CONDITION QA/QC REPORT

This report provides information about the condition of the sample(s)
and associated sample custody information on receipt at the laboratory.

Chain of Custody Form
Completed & Signed

Yes Comments: _____

Chain of Custody Seal

No Comments: _____

Intact

N/A Comments: _____

Signature Match Chain of Custody vs. Seal

N/A Comments: _____

Samples Received Cold

Yes Comments: _____

Samples Received Within Holding Time

Yes Comments: _____

Samples Received in Proper Containers

Yes Comments: _____

Samples Received Properly Preserved

N/A Comments: _____

Samples requiring analysis for volatile organics are tested for proper preservation at the time of analysis.
Any preservation problems encountered for these samples are noted on the analytical parameter report pages.

Client notified about sample discrepancies:

Who: _____ By: _____ Date/Time: _____

Method of Shipping: Fed Ex

Additional comments: Received 1 broken vial for CHHL-9906-101.

2727 Airport Road • Helena, Montana 59601 • (406) 443-4150

[illegible]

Client: Hydrometrics
Date Sampled: 08-JUL-99 14:20
Date Received: 14-JUL-99
Analysis Date: 19-JUL-1999 18:21
Project Info: PROJ. #0054, CITY OF HELENA
Sample Info: CHL-9907-100

Lab No.: 001-99-54704
Report Date: 07/23/99 13:55
Extraction Method: EPA 5030
Sample Matrix: WATER; pH= < 2

EPA METHOD 8260A: VOLATILE ORGANICS ANALYSIS REPORT

COMPOUNDS	CAS NO.	CONCENTRATION UNITS = ug/L (ppb)	RESULT	QUALIFIER
Acetone	67-64-1		<20	U
Acrylonitrile	107-13-1		<20	U
Benzene	71-43-2		<1.0	U
Bromochloromethane	74-97-5		<1.0	U
Bromodichloromethane	75-27-4		<1.0	U
Bromoform	75-25-2		<1.0	U
Bromomethane	74-83-9		<1.0	U
Carbon disulfide	75-15-0		<1.0	U
Carbon tetrachloride	56-23-5		<1.0	U
Chlorobenzene	108-90-7		<1.0	U
Chlorodibromomethane	124-48-1		<1.0	U
Chloroethane	75-00-3		<1.0	U
Chloroform	67-66-3		2.2	
Chloromethane	74-87-3		<1.0	U
1,2-Dibromo-3-chloropropane	96-12-8		<1.0	U
1,2-Dibromoethane	106-93-4		<1.0	U
Dibromomethane	74-95-3		<1.0	U
1,2-Dichlorobenzene	95-50-1		<1.0	U
1,4-Dichlorobenzene	106-46-7		<1.0	U
trans-1,4-Dichloro-2-butene	110-57-6		<2.0	U
Dichlorodifluoromethane	75-71-8		1.4	
1,1-Dichloroethane	75-34-3		1.6	
1,2-Dichloroethane	107-06-2		<1.0	U
1,1-Dichloroethene	75-35-4		<1.0	U
cis-1,2-Dichloroethene	156-59-2		<1.0	0.22J
trans-1,2-Dichloroethene	156-60-5		<1.0	U
1,2-Dichloropropane	78-87-5		<1.0	U
cis-1,3-Dichloropropene	10061-01-5		<1.0	U
trans-1,3-Dichloropropene	10061-02-6		<1.0	U
Ethylbenzene	100-41-4		<1.0	U
2-Hexanone	591-78-6		<20	U
Iodomethane	74-88-4		<1.0	U
Methyl ethyl ketone	78-93-3		<20	U
Methyl isobutyl ketone	108-10-1		<20	U
Methylene chloride	75-09-2		<1.0	0.82J
Styrene	100-42-5		<1.0	U
1,1,1,2-Tetrachloroethane	630-20-6		<1.0	U
1,1,2,2-Tetrachloroethane	79-34-5		<1.0	U
Tetrachloroethene	127-18-4		5.8	
Toluene	108-88-3		<1.0	U
1,1,1-Trichloroethane	71-55-6		1.2	
1,1,2-Trichloroethane	79-00-5		<1.0	U
Trichloroethene	79-01-6		<1.0	0.85J
Trichlorofluoromethane	75-69-4		<1.0	0.75J
1,2,3-Trichloropropane	96-18-4		<1.0	U
Vinyl acetate	108-05-4		<1.0	U
Vinyl chloride	75-01-4		<1.0	U
m+p-Xylenes	108383/106423		<1.0	U
o-Xylene	95-47-6		<1.0	U

SURROGATE RECOVERY REPORT

Surrogate Compound	Added-ug/L	Measured-ug/L	%Rec	QC Limits
1,2-Dichloroethane d4	10.0	10.4	104	80--120
Toluene d8	10.0	10.5	105	80--120
p-Bromofluorobenzene	10.0	10.6	106	80--120

QUALIFIER CODE EXPLANATIONS AND NOTES:

U= Indicates compound was analyzed for but not detected.
J= Estimated value. Present, but less than the limit of quantitation.

REPORT COMMENTS: None

Analyst: G Reviewing Supervisor: mm /chem/5971A.i/va071999.b/jul191101011.d

**ENERGY LABORATORIES, INC.**P.O. BOX 30916 • 1120 SOUTH 27TH STREET • BILLINGS, MT 59107-0916 • PHONE (406) 252-6325
FAX (406) 252-6069 • 1-800-735-4489 • E-MAIL eli@energylab.comClient: Hydrometrics
Date Sampled: 09-JUL-99 12:46
Date Received: 14-JUL-99
Analysis Date: 19-JUL-1999 18:57
Project Info: PROJ. #0054, CITY OF HELENA
Sample Info: CHL-9907-101

HL-99-3

Lab No.: 002-99-54704
Report Date: 07/23/99 13:56
Extraction Method: EPA 5030
Sample Matrix: WATER; pH = < 2**EPA METHOD 8260A: VOLATILE ORGANICS ANALYSIS REPORT**

COMPOUNDS	CAS NO.	CONCENTRATION UNITS = ug/L (ppb)	RESULT	QUALIFIER
Acetone	67-64-1		<20	U
Acrylonitrile	107-13-1		<20	U
Benzene	71-43-2		<1.0	U
Bromochloromethane	74-97-5		<1.0	U
Bromodichloromethane	75-27-4		<1.0	U
Bromoform	75-25-2		<1.0	U
Bromomethane	74-83-9		<1.0	U
Carbon disulfide	75-15-0		<1.0	U
Carbon tetrachloride	56-23-5		<1.0	U
Chlorobenzene	108-90-7		<1.0	U
Chlorodibromomethane	124-48-1		<1.0	U
Chloroethane	75-00-3		<1.0	U
Chloroform	67-66-3		1.8	
Chloromethane	74-87-3		<1.0	U
1,2-Dibromo-3-chloropropane	96-12-8		<1.0	U
1,2-Dibromoethane	106-93-4		<1.0	U
Dibromomethane	74-95-3		<1.0	U
1,2-Dichlorobenzene	95-50-1		<1.0	U
1,4-Dichlorobenzene	106-46-7		<1.0	U
trans-1,4-Dichloro-2-butene	110-57-6		<2.0	U
Dichlorodifluoromethane	75-71-8		6.7	
1,1-Dichloroethane	75-34-3		5.2	
1,2-Dichloroethane	107-06-2		<1.0	U
1,1-Dichloroethene	75-35-4		<1.0	0.41J
cis-1,2-Dichloroethene	156-59-2		<1.0	0.38J
trans-1,2-Dichloroethene	156-60-5		<1.0	U
1,2-Dichloropropane	78-87-5		<1.0	U
cis-1,3-Dichloropropene	10061-01-5		<1.0	U
trans-1,3-Dichloropropene	10061-02-6		<1.0	U
Ethylbenzene	100-41-4		<1.0	U
2-Hexanone	591-78-6		<20	U
Iodomethane	74-88-4		<1.0	U
Methyl ethyl ketone	78-93-3		<20	U
Methyl isobutyl ketone	108-10-1		<20	U
Methylene chloride	75-09-2		6.6	
Styrene	100-42-5		<1.0	U
1,1,1,2-Tetrachloroethane	630-20-6		<1.0	U
1,1,2,2-Tetrachloroethane	79-34-5		<1.0	U
Tetrachloroethene	127-18-4		24	D
Toluene	108-88-3		<1.0	U
1,1,1-Trichloroethane	71-55-6		4.8	
1,1,2-Trichloroethane	79-00-5		<1.0	U
Trichloroethene	79-01-6		3.2	
Trichlorofluoromethane	75-69-4		4.4	
1,2,3-Trichloropropane	96-18-4		<1.0	U
Vinyl acetate	108-05-4		<1.0	U
Vinyl chloride	75-01-4		<1.0	U
m+p-Xylenes	108383/106423		<1.0	U
o-Xylene	95-47-6		<1.0	U

SURROGATE RECOVERY REPORT

Surrogate Compound	Added-ug/L	Measured-ug/L	%Rec	QC Limits
1,2-Dichloroethane d4	10.0	10.7	107	80--120
Toluene d8	10.0	10.3	103	80--120
p-Bromofluorobenzene	10.0	10.9	109	80--120

QUALIFIER CODE EXPLANATIONS AND NOTES:

- U= Indicates compound was analyzed for but not detected.
- D= Value derived from a 10 times dilution of the sample extract.
- J= Estimated value. Present, but less than the limit of quantitation.

REPORT COMMENTS: None

Analyst: *o* Reviewing Supervisor: *MD* /chem/5971A.i/va071999.b/jul191201012.d

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FAX (406) 252-6069 • 1-800-735-4489 • E-MAIL eli@energylab.comClient: Hydrometrics
Date Sampled: 12-JUL-99 14:52
Date Received: 14-JUL-99
Analysis Date: 19-JUL-1999 19:31
Project Info: PROJ. #0054, CITY OF HELENA
Sample Info: CHL-9907-102Lab No.: 003-99-54704
Report Date: 07/23/99 13:56
Extraction Method: EPA 5030
Sample Matrix: WATER; pH= < 2**EPA METHOD 8260A: VOLATILE ORGANICS ANALYSIS REPORT**

COMPOUNDS	CONCENTRATION UNITS = ug/L (ppb)		QUALIFIER
	CAS NO.	RESULT	
Acetone	67-64-1	<20	U
Acrylonitrile	107-13-1	<20	U
Benzene	71-43-2	<1.0	U
Bromochloromethane	74-97-5	<1.0	U
Bromodichloromethane	75-27-4	<1.0	U
Bromoform	75-25-2	<1.0	U
Bromomethane	74-83-9	<1.0	U
Carbon disulfide	75-15-0	<1.0	U
Carbon tetrachloride	56-23-5	<1.0	U
Chlorobenzene	108-90-7	<1.0	U
Chlorodibromomethane	124-48-1	<1.0	U
Chloroethane	75-00-3	<1.0	U
Chloroform	67-66-3	2.5	
Chloromethane	74-87-3	<1.0	U
1,2-Dibromo-3-chloropropane	96-12-8	<1.0	U
1,2-Dibromoethane	106-93-4	<1.0	U
Dibromomethane	74-95-3	<1.0	U
1,2-Dichlorobenzene	95-50-1	<1.0	U
1,4-Dichlorobenzene	106-46-7	<1.0	U
trans-1,4-Dichloro-2-butene	110-57-6	<2.0	U
Dichlorodifluoromethane	75-71-8	1.2	
1,1-Dichloroethane	75-34-3	1.3	
1,2-Dichloroethane	107-06-2	<1.0	U
1,1-Dichloroethene	75-35-4	<1.0	U
cis-1,2-Dichloroethene	156-59-2	1.1	
trans-1,2-Dichloroethene	156-60-5	<1.0	U
1,2-Dichloropropane	78-87-5	<1.0	U
cis-1,3-Dichloropropene	10061-01-5	<1.0	U
trans-1,3-Dichloropropene	10061-02-6	<1.0	U
Ethylbenzene	100-41-4	<1.0	U
2-Hexanone	591-78-6	<20	U
Iodomethane	74-88-4	<1.0	U
Methyl ethyl ketone	78-93-3	<20	U
Methyl isobutyl ketone	108-10-1	<20	U
Methylene chloride	75-09-2	<1.0	U
Styrene	100-42-5	<1.0	U
1,1,1,2-Tetrachloroethane	630-20-6	<1.0	U
1,1,2,2-Tetrachloroethane	79-34-5	<1.0	U
Tetrachloroethene	127-18-4	7.8	
Toluene	108-88-3	<1.0	U
1,1,1-Trichloroethane	71-55-6	<1.0	0.83J
1,1,2-Trichloroethane	79-00-5	<1.0	U
Trichloroethene	79-01-6	1.0	
Trichlorofluoromethane	75-69-4	<1.0	0.46J
1,2,3-Trichloropropane	96-18-4	<1.0	U
Vinyl acetate	108-05-4	<1.0	U
Vinyl chloride	75-01-4	<1.0	U
m+p-Xylenes	108383/106423	<1.0	U
o-Xylene	95-47-6	<1.0	U

SURROGATE RECOVERY REPORT

Surrogate Compound	Added-ug/L	Measured-ug/L	%Rec	QC Limits
1,2-Dichloroethane d4	10.0	10.6	106	80--120
Toluene d8	10.0	10.6	106	80--120
p-Bromofluorobenzene	10.0	10.3	103	80--120

QUALIFIER CODE EXPLANATIONS AND NOTES:

- U= Indicates compound was analyzed for but not detected.
- J= Estimated value. Present, but less than the limit of quantitation.

REPORT COMMENTS: None

Analyst: Reviewing Supervisor: /chem/5971A.i/va071999.b/jul191301013.d

EPA METHOD 8260A: QUALITY ASSURANCE MATRIX SPIKE REPORT

Quality Control Sample: Matrix Spike Analysis 22-JUL-1999 14:51

Lab No.: 001-99-54704ms

Report Date: 07/23/99 13:47

Extraction Method: EPA 5030

Sample Matrix: WATER

File: /chem/5971A.i/va072299.b/jul221101011.d

Remarks: These compounds were spiked into the sample matrix to determine if the sample matrix contributes bias to the analytical results and to monitor the accuracy of the methodology.

Spike Compound	CONCENTRATION UNITS = ug/L (ppb)				
	Spike Added	Sample Concentration	Matrix Spike Concentration	MS %Rec	QC Limits
Benzene	10.0	<1.00	11.2	112	60--140
Chlorobenzene	10.0	<1.00	11.0	110	60--140
1,1-Dichloroethene	10.0	<1.00	11.8	118	60--140
Toluene	10.0	<1.00	10.8	108	60--140
Trichloroethene	10.0	<1.00	12.6	126	60--140

SURROGATE RECOVERY REPORT

Surrogate Compound	Added-ug/L	Measured-ug/L	%Rec	QC Limits
1,2-Dichloroethane d4	20.0	21.6	108	80--120
Toluene d8	20.0	20.4	102	80--120
p-Bromofluorobenzene	20.0	21.2	106	80--120

EPA METHOD 8260A: QUALITY ASSURANCE MATRIX SPIKE DUPLICATE REPORT

Quality Control Sample: Matrix Spike Duplicate Analysis 22-JUL-1999 15:27

Lab No.: 001-99-54704msd

File: /chem/5971A.i/va072299.b/jul221201012.d

Remarks: These compounds were again spiked into the sample matrix to determine if the sample matrix contributes bias to the analytical results and to monitor the accuracy and precision of the methodology.

Spike Compound	CONCENTRATION UNITS = ug/L (ppb)					---QC Limits---	
	Spike Added	Matrix Spike Dup. Conc.	MSD %Rec	%RPD	RPD	Rec	
Benzene	10.0	11.3	113	1	11	60--140	
Chlorobenzene	10.0	10.7	107	3	13	60--140	
1,1-Dichloroethene	10.0	11.8	118	0	14	60--140	
Toluene	10.0	10.8	108	0	13	60--140	
Trichloroethene	10.0	12.5	125	1	14	60--140	

SURROGATE RECOVERY REPORT

Surrogate Compound	Added-ug/L	Measured-ug/L	%Rec	QC Limits
1,2-Dichloroethane d4	20.0	21.3	106	80--120
Toluene d8	20.0	20.4	102	80--120
p-Bromofluorobenzene	20.0	21.2	106	80--120

REPORT COMMENTS: The sample was diluted by 2 times before spiking.

Analyst: S Reviewing Supervisor: wnj

EPA METHOD 8260A: QUALITY ASSURANCE BLANK MATRIX SPIKE REPORT

Quality Control Sample: Reference Sample Analysis 19-JUL-1999 11:29

Report Date: 07/23/99 13:58

Extraction Method: EPA 5030

Sample Matrix: WATER

File: /chem/5971A.i/va071999.b/jul190301003.d

Remarks: This reference sample was spiked into a blank sample matrix then extracted and analyzed with your set of samples to determine if the methodology is in control and to monitor the laboratory's ability to produce accurate results.

Spike Compound	CONCENTRATION UNITS = ug/L (ppb)			
	Added	Measured	%Rec	QC Limits
-----	-----	-----	-----	-----
Acetone	50.0	45.4	91	60--140
Benzene	5.00	4.86	97	60--140
Bromochloromethane	5.00	4.74	95	60--140
Bromodichloromethane	5.00	5.01	100	60--140
Bromoform	5.00	4.85	97	60--140
Bromomethane	5.00	4.87	97	60--140
Carbon tetrachloride	5.00	4.96	99	60--140
Chlorobenzene	5.00	5.06	101	60--140
Chlorodibromomethane	5.00	4.84	97	60--140
Chloroethane	5.00	5.04	101	60--140
Chloroform	5.00	4.68	94	60--140
Chloromethane	5.00	5.81	116	60--140
1,2-Dibromo-3-chloropropane	5.00	4.48	90	60--140
1,2-Dibromoethane	5.00	4.97	99	60--140
Dibromomethane	5.00	5.08	102	60--140
1,2-Dichlorobenzene	5.00	4.34	87	60--140
1,4-Dichlorobenzene	5.00	4.93	99	60--140
Dichlorodifluoromethane	5.00	5.10	102	60--140
1,1-Dichloroethane	5.00	4.86	97	60--140
1,1-Dichloroethene	5.00	5.02	100	60--140
cis-1,2-Dichloroethene	5.00	4.72	94	60--140
trans-1,2-Dichloroethene	5.00	4.99	100	60--140
1,2-Dichloropropane	5.00	5.05	101	60--140
cis-1,3-Dichloropropene	5.00	5.73	115	60--140
trans-1,3-Dichloropropene	5.00	4.88	98	60--140
Ethylbenzene	5.00	5.27	105	60--140
2-Hexanone	50.0	48.3	97	60--140
Methyl ethyl ketone	50.0	47.0	94	60--140
Methyl isobutyl ketone	50.0	51.2	102	60--140
Methylene chloride	5.00	4.66	93	60--140
Styrene	5.00	5.02	100	60--140
1,1,1,2-Tetrachloroethane	5.00	4.93	99	60--140
1,1,2,2-Tetrachloroethane	5.00	4.75	95	60--140
Tetrachloroethene	5.00	5.02	100	60--140
Toluene	5.00	5.09	102	60--140
1,1,1-Trichloroethane	5.00	4.70	94	60--140
1,1,2-Trichloroethane	5.00	4.96	99	60--140
Trichloroethene	5.00	5.28	106	60--140
Trichlorofluoromethane	5.00	4.29	86	60--140
1,2,3-Trichloropropane	5.00	4.92	98	60--140
Vinyl chloride	5.00	4.72	94	60--140
m+p-Xylenes	10.0	10.4	104	60--140
o-Xylene	5.00	5.08	102	60--140

SURROGATE RECOVERY REPORT

Surrogate Compound	Added-ug/L	Measured-ug/L	%Rec	QC Limits
1,2-Dichloroethane d4	10.0	9.18	92	80--120
Toluene d8	10.0	10.7	107	80--120
p-Bromofluorobenzene	10.0	10.8	108	80--120

REPORT COMMENTS: None

Analyst: Reviewing Supervisor:

Quality Control Sample: Laboratory Reagent Blank 19-JUL-1999 12:39

Report Date: 07/23/99 14:03

Extraction Method: EPA 5030

Sample Matrix: WATER

Remarks: This Laboratory Reagent Blank Quality Control Sample was extracted and analyzed with your set of samples to determine if method analytes or other interferences are present in the laboratory environment, the reagents, or the apparatus.

EPA METHOD 8260A: VOLATILE ORGANICS ANALYSIS REPORT

CONCENTRATION UNITS = ug/L (ppb)			
COMPOUNDS	CAS NO.	RESULT	QUALIFIER
Acetone	67-64-1	<20	U
Acrylonitrile	107-13-1	<20	U
Benzene	71-43-2	<1.0	U
Bromochloromethane	74-97-5	<1.0	U
Bromodichloromethane	75-27-4	<1.0	U
Bromoform	75-25-2	<1.0	U
Bromomethane	74-83-9	<1.0	U
Carbon disulfide	75-15-0	<1.0	U
Carbon tetrachloride	56-23-5	<1.0	U
Chlorobenzene	108-90-7	<1.0	U
Chlorodibromomethane	124-48-1	<1.0	U
Chloroethane	75-00-3	<1.0	U
Chloroform	67-66-3	<1.0	U
Chloromethane	74-87-3	<1.0	U
1,2-Dibromo-3-chloropropane	96-12-8	<1.0	U
1,2-Dibromoethane	106-93-4	<1.0	U
Dibromomethane	74-95-3	<1.0	U
1,2-Dichlorobenzene	95-50-1	<1.0	U
1,4-Dichlorobenzene	106-46-7	<1.0	U
trans-1,4-Dichloro-2-butene	110-57-6	<2.0	U
Dichlorodifluoromethane	75-71-8	<1.0	U
1,1-Dichloroethane	75-34-3	<1.0	U
1,2-Dichloroethane	107-06-2	<1.0	U
1,1-Dichloroethene	75-35-4	<1.0	U
cis-1,2-Dichloroethene	156-59-2	<1.0	U
trans-1,2-Dichloroethene	156-60-5	<1.0	U
1,2-Dichloropropane	78-87-5	<1.0	U
cis-1,3-Dichloropropene	10061-01-5	<1.0	U
trans-1,3-Dichloropropene	10061-02-6	<1.0	U
Ethylbenzene	100-41-4	<1.0	U
2-Hexanone	591-78-6	<20	U
Iodomethane	74-88-4	<1.0	U
Methyl ethyl ketone	78-93-3	<20	U
Methyl isobutyl ketone	108-10-1	<20	U
Methylene chloride	75-09-2	<1.0	U
Styrene	100-42-5	<1.0	U
1,1,1,2-Tetrachloroethane	630-20-6	<1.0	U
1,1,2,2-Tetrachloroethane	79-34-5	<1.0	U
Tetrachloroethene	127-18-4	<1.0	U
Toluene	108-88-3	<1.0	U
1,1,1-Trichloroethane	71-55-6	<1.0	U
1,1,2-Trichloroethane	79-00-5	<1.0	U
Trichloroethene	79-01-6	<1.0	U
Trichlorofluoromethane	75-69-4	<1.0	U
1,2,3-Trichloropropane	96-18-4	<1.0	U
Vinyl acetate	108-05-4	<1.0	U
Vinyl chloride	75-01-4	<1.0	U
m+p-Xylenes	108383/106423	<1.0	U
o-Xylene	95-47-6	<1.0	U

SURROGATE RECOVERY REPORT

Surrogate Compound	Added-ug/L	Measured-ug/L	%Rec	QC Limits
1,2-Dichloroethane d4	10.0	9.75	98	80--120
Toluene d8	10.0	10.3	103	80--120
p-Bromofluorobenzene	10.0	11.0	110	80--120

QUALIFIER CODE EXPLANATIONS AND NOTES:

U= Indicates compound was analyzed for but not detected.

REPORT COMMENTS: None

Analyst: Reviewing Supervisor: /chem/5971A.i/va071999.b/jul190501005.d

Lab Nos.: 001-99-54704 - 003-99-54704

Date: 14-JUL-99

Received by: Randa Hoelscher

Logged In by: Randa Hoelscher

SAMPLE CONDITION QA/QC REPORT

This report provides information about the condition of the sample(s)
and associated sample custody information on receipt at the laboratory.

Chain of Custody Form
Completed & Signed

Yes Comments: _____

Chain of Custody Seal

Yes Comments: _____

Intact

Yes Comments: _____

Signature Match Chain of Custody vs. Seal

Yes Comments: _____

Samples Received Cold

No Comments: _____

Samples Received Within Holding Time

Yes Comments: _____

Samples Received in Proper Containers

Yes Comments: _____

Samples Received Properly Preserved

N/A Comments: _____

**Samples requiring analysis for volatile organics are tested for proper preservation at the time of analysis.
Any preservation problems encountered for these samples are noted on the analytical parameter report pages.**

Client notified about sample discrepancies:

Who: _____ By: _____ Date/Time: _____

Method of Shipping: UPS Ground

Additional comments: pc: Jodi Bingham, Hydrometrics, Helena

CHAIN OF CUSTODY RECORD

2727 Airport Road • Helena, Montana 59601 • (406) 443-4150

PROJ. NO.		PROJECT NAME			NO. OF CON- TAINERS	4014H / W's / 1 Seal Commons UF/RAW Nutrients UF/H₂SO₄ Diss. Metal F/HNO₃ CN UF/NaOH Total Metals UF/HNO₃ Total Recoverable Metals UF/HNO₃ BTEX TPH VOC														REMARKS																			
SAMPLERS: (Signature)																																							
DATE	TIME	COMP.	GRAB	SAMPLE NUMBER																																			
7/8/99	1420		✓	CHL-9907-100	2														✓	001-99-54704																			
7/8/99	1246		✓	CHL-9907-101	2														✓	002																			
7/8/99	1452		✓	CHL-9907-102	2														✓	003																			
X																																							
Relinquished (Signature)		Date/Time		Received by: (Signature)		Lab				P.O. #		Shipped via: Bus, Fed Ex, UPS																											
		7/13/99 0800				Energy				H07271		Other Hand Carried																											
Relinquished (Signature)		Date/Time		Received by: (Signature)		Remarks																																	
Relinquished (Signature)		Date/Time		Received for Laboratory by: (Signature)		Date/Time		Enclosed: ☒ Parameter sheet w/detection limits ☐ QA/QC standard mixing instructions ☒ Cover letter ☐ Other																															
						07/14/99 1040																																	
Split Samples:						☐ Accepted ☐ Declined																																	
						Signature																																	

HFORM-1-4/95

Return results & electronic copy to:
Computer Dept. at address at top of page

THURSDAY, AUGUST 14, 1996 9:41:08 PM
SUMMARY OF MODEL INPUT PARAMETERS

Aquifer layer data

Base elevation: 142.00
Hydraulic conductivity of lower layer: 4.0000
Thickness of lower layer: 10.0000
Hydraulic conductivity of upper layer: 4.0000
Thickness of upper layer: 10.0000
Minimum soil depth for soil in calculation: 20.0000

Reference point data

Specified head: 100.00
X coordinate of reference point: 12.000
Y coordinate of reference point: 41.000

Boundary condition data

Uniform specific discharge rate: 4.0000
Angle of uniform flow direction from x axis: 90.000

Circular areas of land recharge

Column 1: Circular recharge area number
Column 2: Recharge radius
Column 3: Recharge rate
Column 4: X coordinate of circle center
Column 5: Y coordinate of circle center

APPENDIX D

SECONDARY MODEL INPUTS AND OUTPUTS

Truncated well layer data

Total number of truncated wells: 3
1.1: 100.0000
Time for evaluating truncated well functions: 0.0100
Column 1: Truncated well number
Column 2: x coordinate of well
Column 3: y coordinate of well
Column 4: radius of well
Column 5: Recharge rate of well
Column 6: Starting time of pumping
1: 100.00 422.00 250.00 100.00 10.00
2: 100.00 422.00 250.00 100.00 10.00
3: 100.00 422.00 250.00 100.00 10.00

Base for aquifer heterogeneity number: 1. Canal Canals: 100.0000

Base elevation: 142.00
Hydraulic conductivity of lower layer: 4.00 100.0000
Thickness of lower layer: 10.0000
Hydraulic conductivity of upper layer: 4.00 100.0000
Thickness of upper layer: 10.0000
Number of nodes used in defining polygon: 3

TWODAN version 5.0. Monday, August 02, 1999 9:41:04 PM
SUMMARY OF MODEL INPUT PARAMETERS

Aquifer input data:

Base elevation: 3820.00
Hydraulic conductivity of lower layer : 4.00000
Thickness of lower layer: 60.0000
Hydraulic conductivity of upper layer : 4.00000
Thickness of upper layer: 100.000
Minimum sat. thick. for solve calculations.: .500000

Reference head input data:

Specified head: 3880.00
x coordinate of reference point: 5248.04
Y coordinate of reference point: 4219.59

Uniform crossflow data:

Uniform aquifer discharge rate: 4.20000
Angle of uniform flow direction from x axis: 90.0000

Circular areas of local recharge:

Column 1: Circular recharge area number
Column 2: Incremental recharge rate within circle
Column 3: x coordinate of circle center
Column 4: y coordinate of circle center
Column 5: Radius of circle
1 .100000 8737.24 3801.41 205.552

Transient well input data:

Total number of transient wells: 3
S/T: .100000E-03
Time for evaluating transient well functions: .000000
Column 1: transient well number
Column 2: x coordinate of well
Column 3: y coordinate of well
Column 4: radius of well
Column 6: discharge of well
Column 7: Starting time of pumping
1 6904.59 4002.40 .250000 5400.00 .000000
2 6609.62 4087.93 .250000 4400.00 .000000
3 7304.78 3854.47 .250000 5400.00 .000000

Data for aquifer heterogeneity number 1: Carol College Bedrock Knob

Base elevation: 3820.00
Hydraulic conductivity of lower layer : .100 0.03 ft/day
Thickness of lower layer: 60.0000
Hydraulic conductivity of upper layer : .100 0.03 ft/day
Thickness of upper layer: 100.000
Number of corner points defining polygon: 4

Area covered by heterogeneity: 908888.

Heterogeneity boundary data:

Column 1: x coordinate of corner point

Column 2: y coordinate of corner point

Column 3: Estimate of head at corner point

6125.29	2532.34	3910.13
---------	---------	---------

6092.13	3679.43	3888.23
---------	---------	---------

7197.52	2955.53	3901.87
---------	---------	---------

7396.49	2498.93	3912.11
---------	---------	---------

The following sections check if the solution met
specified boundary conditions at time = .000000

Reference point boundary condition:

Specified head at reference point: 3880.00

Model-calculated head at reference point: 3880.00

Boundary conditions, heterogeneity number 1

Column 1: Type of control point - corner or midpoint

Column 2: Corner or midpoint number

Column 3: Model-calculated head difference across boundary at control point,
inside head - outside head.

Corner	1	.000000
--------	---	---------

Midpoint	1	-.244141E-03
----------	---	--------------

Corner	2	-.488281E-03
--------	---	--------------

Midpoint	2	.000000
----------	---	---------

Corner	3	.000000
--------	---	---------

Midpoint	3	-.244141E-03
----------	---	--------------

Corner	4	-.244141E-03
--------	---	--------------

Midpoint	4	-.244141E-03
----------	---	--------------

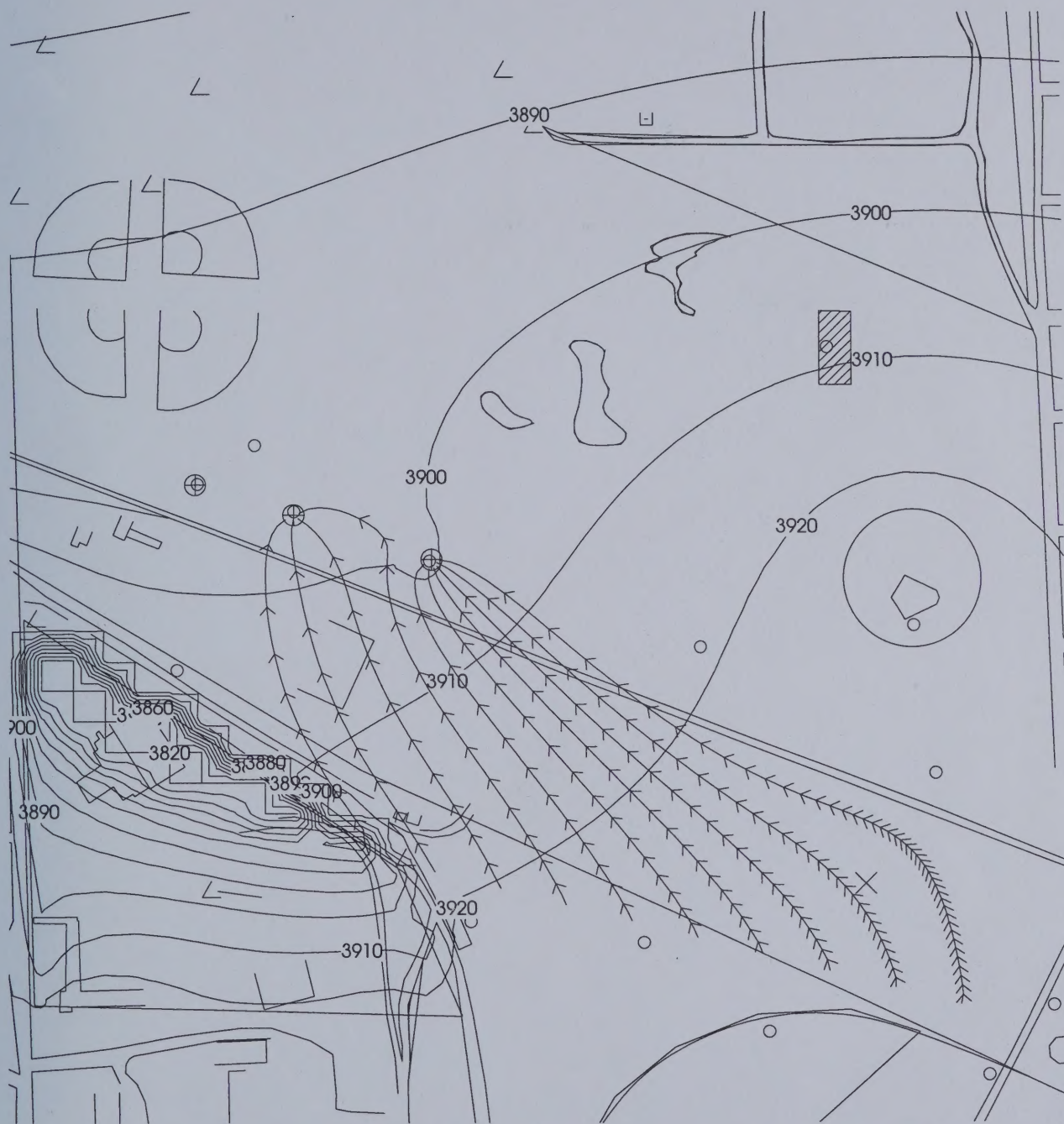


X span: 6050.599 to 9191.309 Y span: 2184.491 to 5483.981

Pre-Pumping Water Table

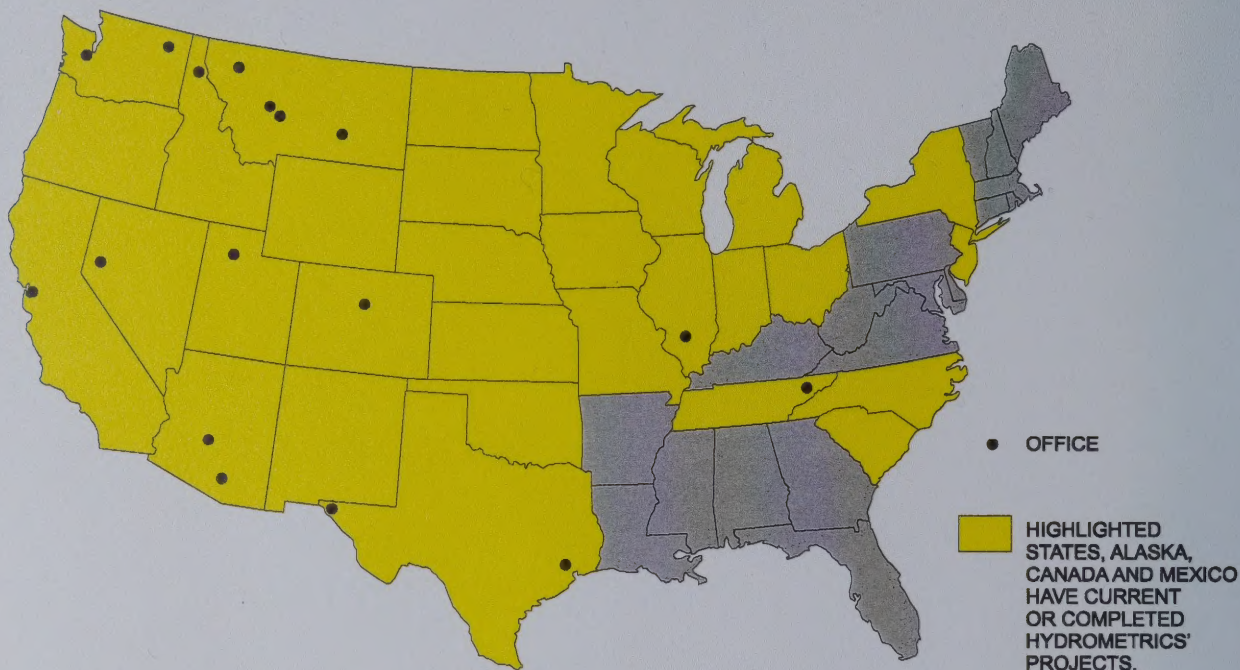
HELENA LANDFILL

TWODAN SIMULATION



X span: 6050.599 to 9191.309 Y span: 2184.491 to 5483.981

Pumping Simulation
HELENA LANDFILL
TWODAN SIMULATION



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